MACHINE DESIGN

September 1949

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CHUTING MECHANISMS
PAINT SPECIFICATIONS
CENTRIFUGAL CASTINGS
ELECTRONIC ANALOGUE
BEAM DEFLECTIONS

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Hooking up 100 kw, 2400 v. generator after h. v. test

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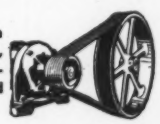

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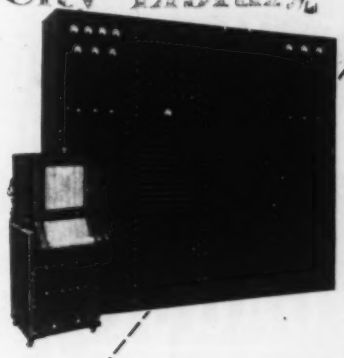

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MACHINE DESIGN

Vol. 21—No. 9 September, 1949

THE PROFESSIONAL JOURNAL OF CHIEF ENGINEERS AND DESIGNERS

This Month's Cover: Head of Bausch & Lomb grinder for generating spherical surfaces with a metal-bonded diamond ring tool. Features of this machine are discussed in the article beginning on Page 88.

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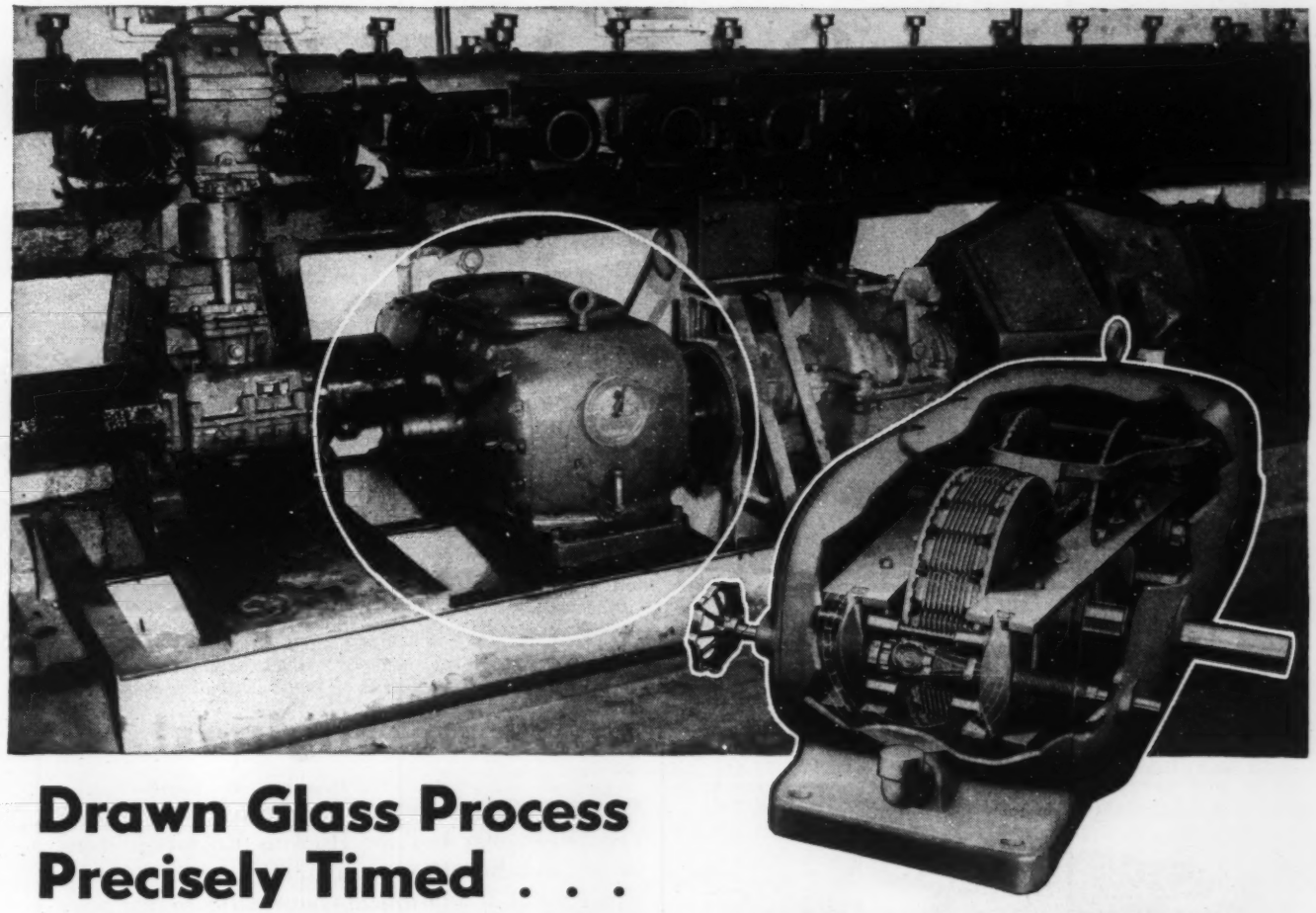

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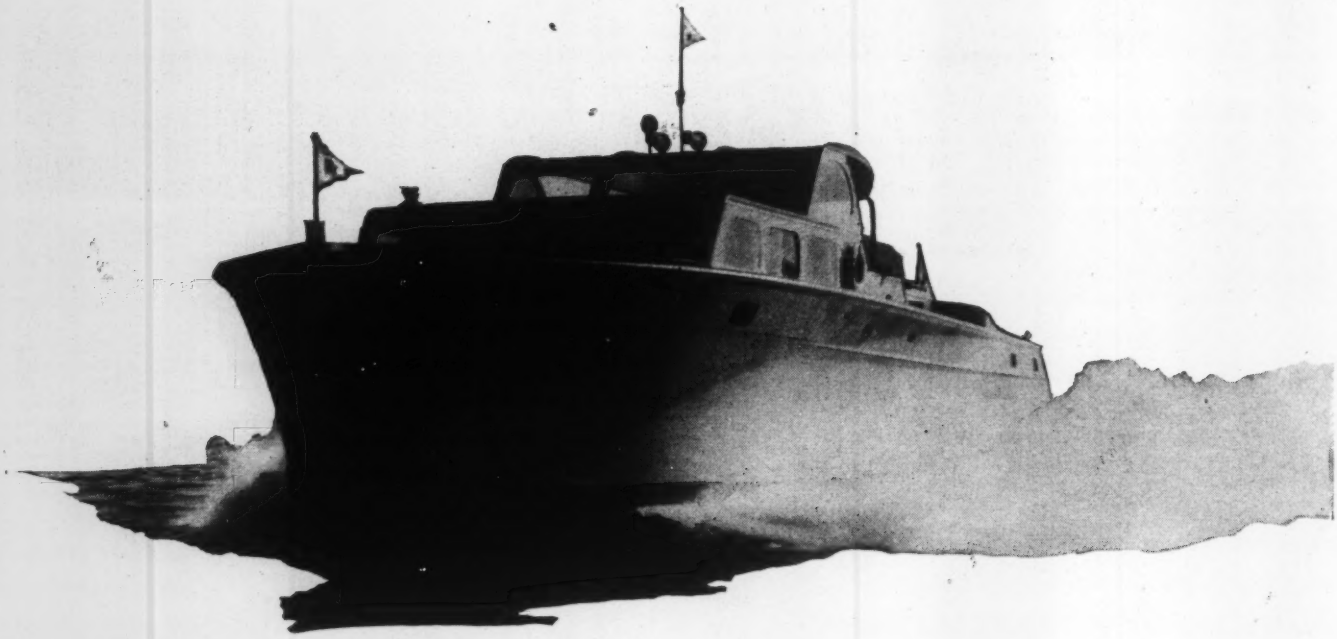
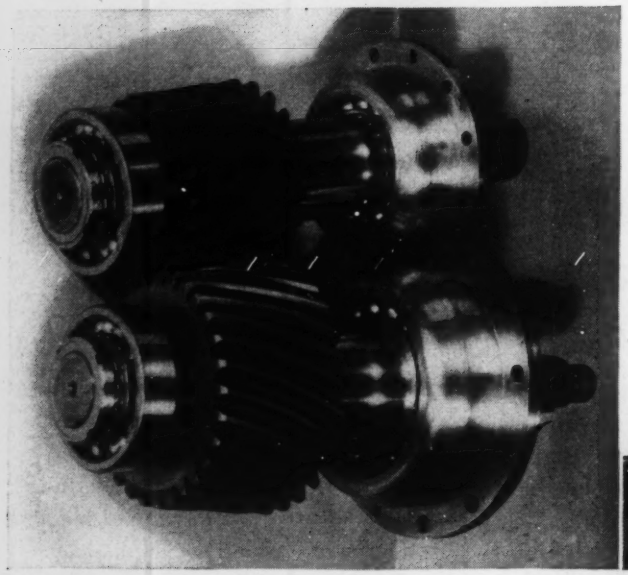


Vee Drive Ball Bearings outlast 2 pairs of engines!



The New Departure ball bearings supporting these spiral bevel gears take heavy thrust and radial loads, but they never require adjustment for wear.

The New Departure ball bearings in the original Vee Drive gear box for Huckins Engines-in-stern yachts, installed 15 years ago, have never required replacement or adjustment—*have outworn two pairs of engines.*

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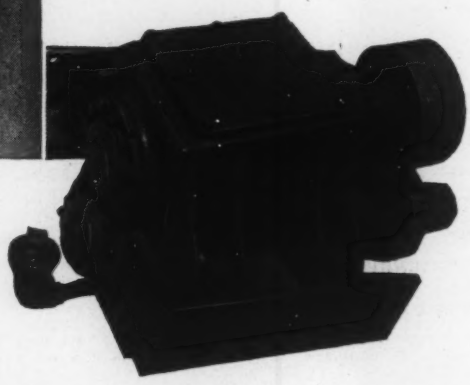
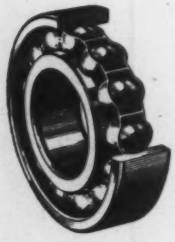


Vee Drive Gear Box used in Fairform Flyer Yachts with Engines in the stern.



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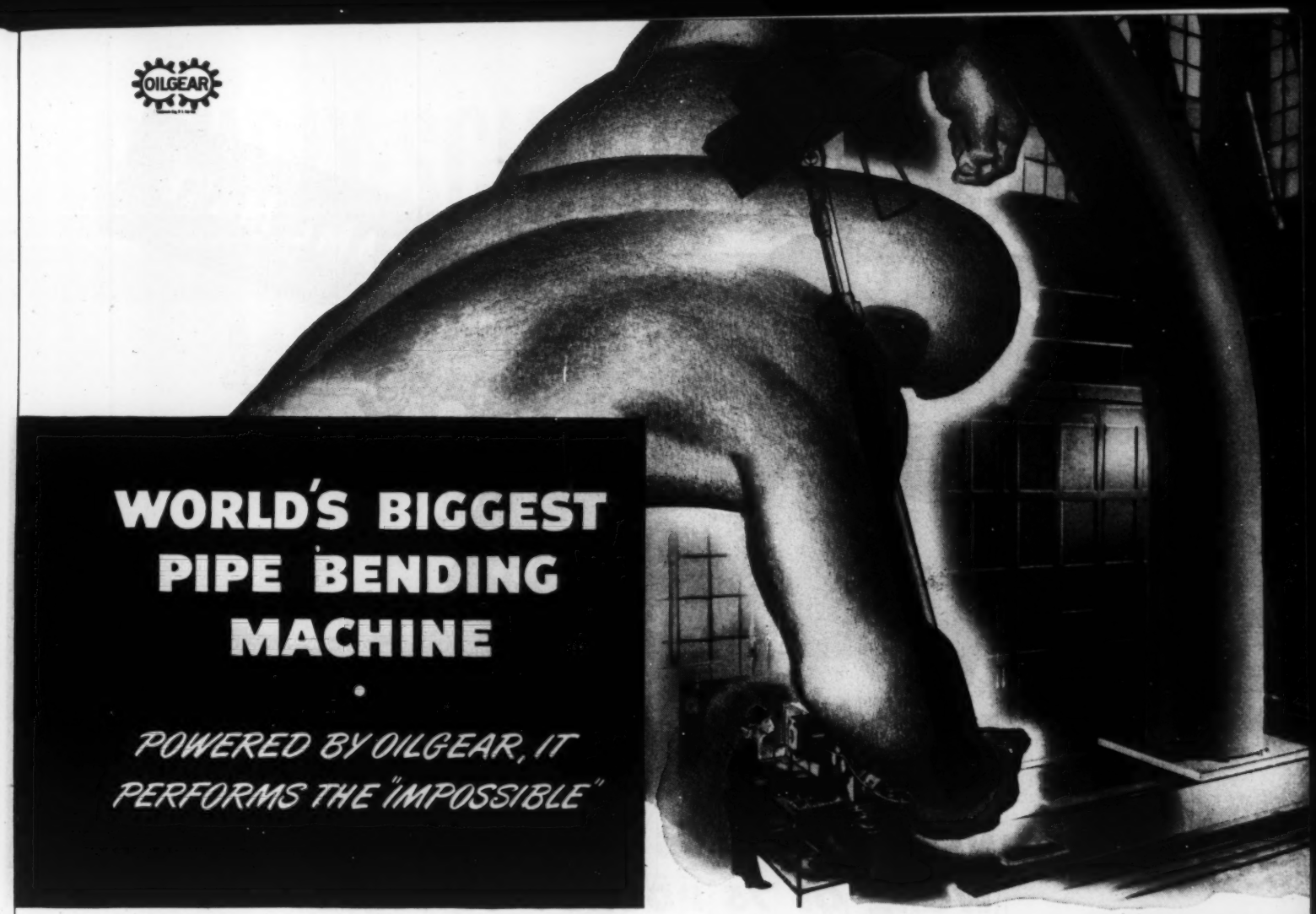

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Prior to the advent of the machine pictured above it was just not possible to bend a pipe over 30 inches in diameter without its buckling and distortion beyond the point of usefulness.

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Here is just one of hundreds of machine and process problems "impossible" of solution to begin with, but solved either directly or indirectly through the application of Oilgear engineering and Oilgear equipment. Why don't you find out what Oilgear can do for you? Many different functions are available. Savings in time and money and labor plus improvements in quality are the result. The Oilgear Company, 1568 West Pierce Street, Milwaukee 4, Wisconsin.

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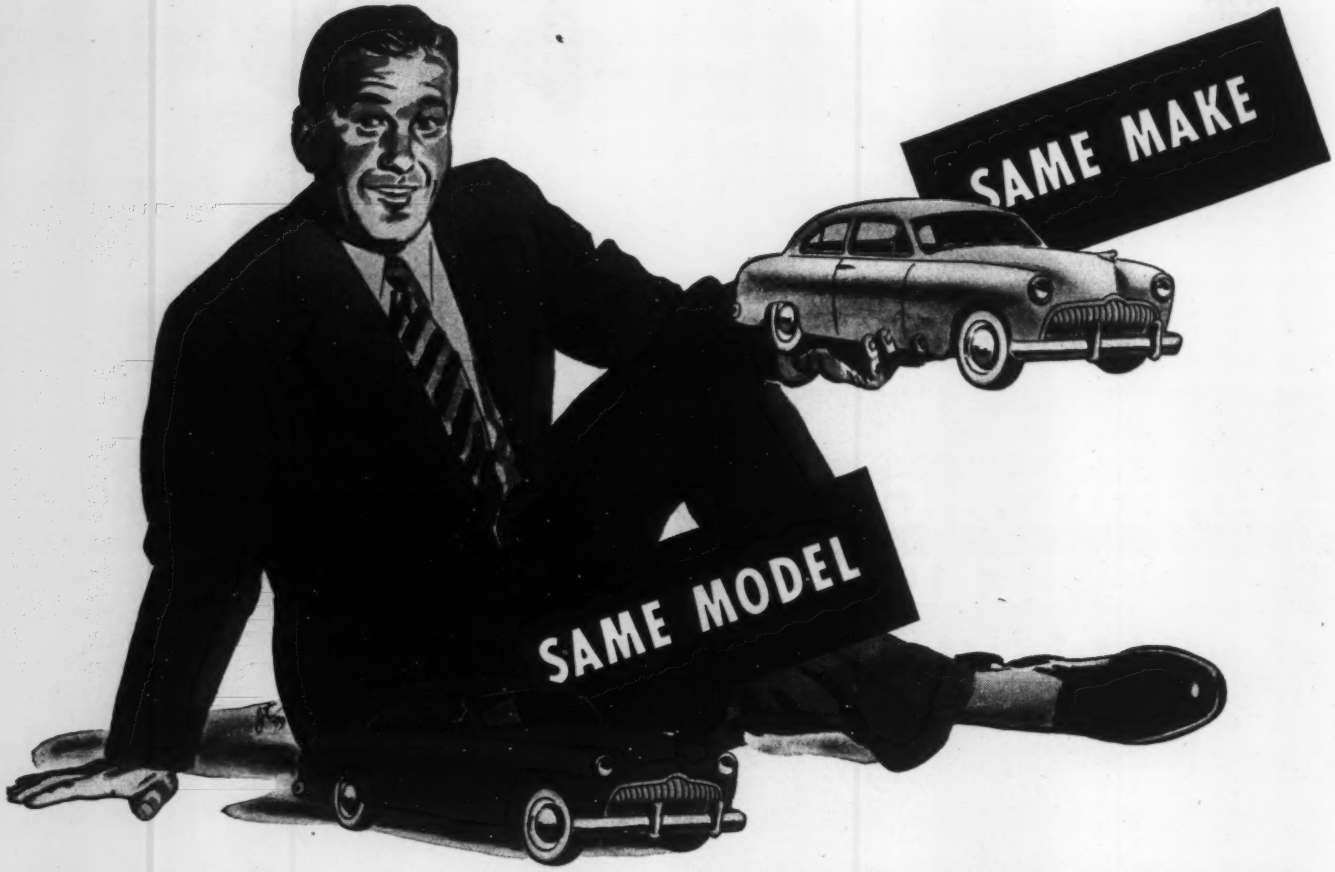


YET IN ONE, 30 POUNDS OF ALUMINUM DOES THE WORK OF 75 POUNDS OF STEEL*

Seeing these two autos speeding down the highway you couldn't tell them apart. Yet one is lighter, built better, will operate for less. The maker uses 30 pounds of aluminum where he once required 75 pounds of steel. He eliminates rust hazard and gives his customers eye-catching finishes that stay attractive through years of use.

Company executives have found the true cost of aluminum is finished cost in their product. Right from the start you get three times more metal to work with when you use aluminum instead of steel or other common metals. There's less weight to ship both coming and going. Many die maintenance problems are ended. Production figures show aluminum is easier to work. Sales figures show consumers appreciate aluminum's advantages.

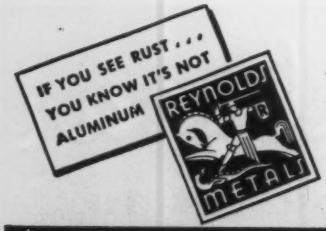
Today aluminum is a whole family of metals. And Reynolds *Lifetime* Aluminum is available in many forms to serve you best: pig, ingot, sheet, plate, wire, rod, bar, screw machine stock, pipe, tubing, structurals and extrusions. With them you also get the assistance of Reynolds technical service department on product redesign and production.

Beat competition to market with improved, lower cost aluminum designs. Call the nearby Reynolds Field Office or Distributor, listed under "Aluminum" in your classified phone directory. Or write direct to Reynolds Metals Company, Aluminum Division, 2521 South Third Street, Louisville 1, Kentucky.

REYNOLDS ALLOY DATA BOOK

A 162-page book with complete data on aluminum alloys and mill products. Free when requested on your company letterhead.

*Verified report from a major auto maker.

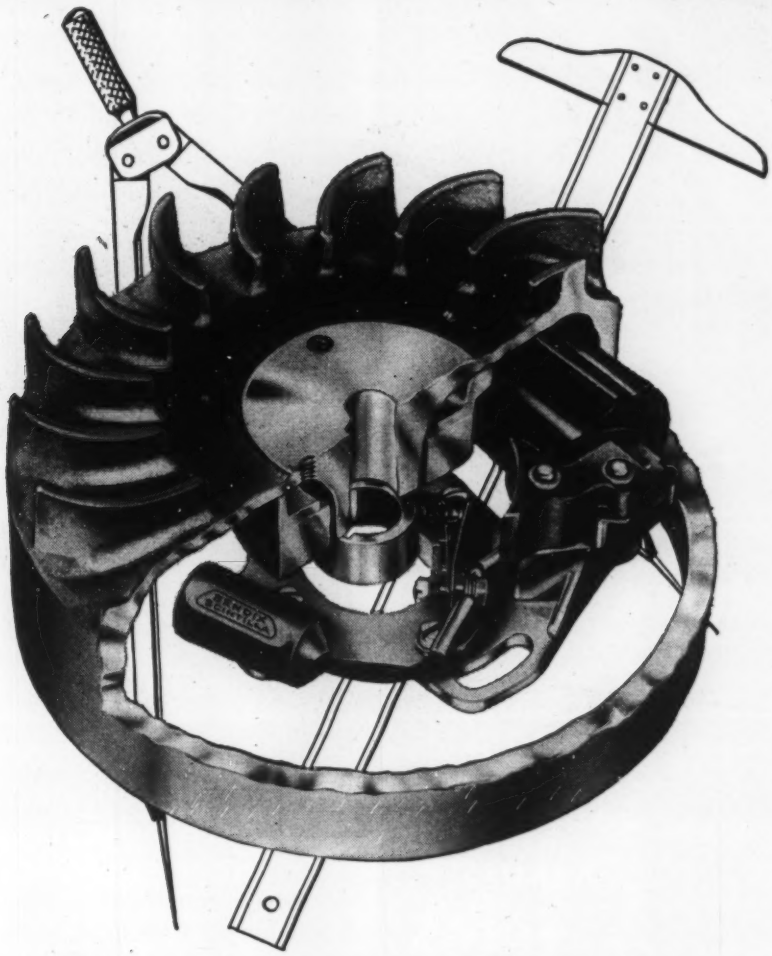


REYNOLDS *Lifetime* ALUMINUM

CONSIDER ALUMINUM . . . CONSULT REYNOLDS . . . THE COMPLETE ALUMINUM SERVICE

BENDIX-SCINTILLA FLYWHEEL-TYPE MAGNETO

FOR 1- AND 2-CYLINDER ENGINES



Simple in Design

Simplicity in design is one of the many reasons for the outstanding performance of Bendix-Scintilla Flywheel Magnetos. The complicated circuits and congested areas of part installations have been avoided. Expert engineering of design has reduced the number of parts to a minimum, and placed them in the best position for high efficiency and easy maintenance. Why not investigate the many advantages of the Bendix-Scintilla Flywheel Magneto today?

BENDIX-SCINTILLA BRINGS YOU ALL THESE OTHER ADVANTAGES

Molded condenser . . . Lower operating cost . . . Minimum lubrication requirements . . . Waterproof molded coil . . . Peak efficiency at high or low speeds . . . Light in weight.

For Further Details and Suggested Applications,
WRITE DIRECT TO THE SALES DEPARTMENT

BENDIX SCINTILLA

SCINTILLA MAGNETO DIVISION of
SIDNEY, NEW YORK

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

PRODUCT DESIGN STUDIES • NO. 21

Cost Reduced 12%
Weight Reduced 5%
Dependability Assured
with STEEL CASTINGS

This is an idler gear rocker arm. It is a part of a steam locomotive booster. Weight before redesign to a steel casting — 147 pounds.

Although the manufacturer was making the rocker arm as a weldment in his own plant, he was interested in discussing the advantages of a steel casting, which he would have to buy outside.

Consultation between the engineering department of the manufacturing company and the steel foundry engineer resulted in a 12% lower cost and 5% lower weight plus other important benefits. A marked increase in dependability was obtained through greater rigidity with toughness, and additional strength where needed — because of better distribution of the metal.

Conversion of some of *your* high-strength parts to steel castings may result in equal if not greater benefits than those shown here.

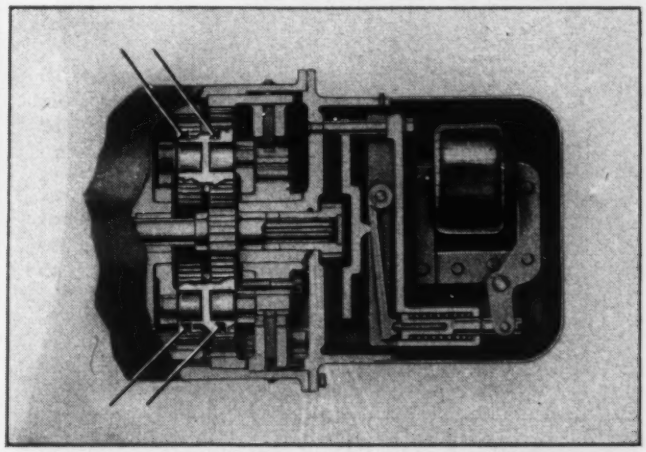
Also in new and redesigned parts, your steel foundry engineer may be able to suggest ways to cut costs and weight and obtain other substantial benefits . . . if you call him in for a discussion *while your product is still on the drawing board.*

This service is offered without cost or obligation. It makes available through your foundry engineer the full results of the development and research program carried on by Steel Founders' Society of America.

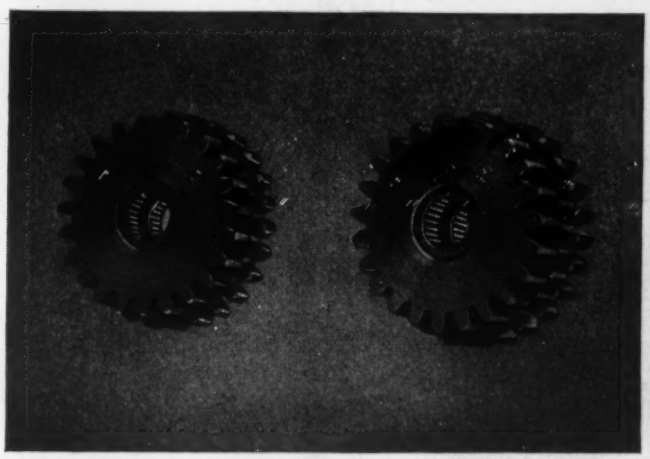
STEEL FOUNDERS' SOCIETY OF AMERICA

Torrington Needle Bearings Give Smooth, Reliable Service in Harnischfeger P&H Zip-Lift Hoists

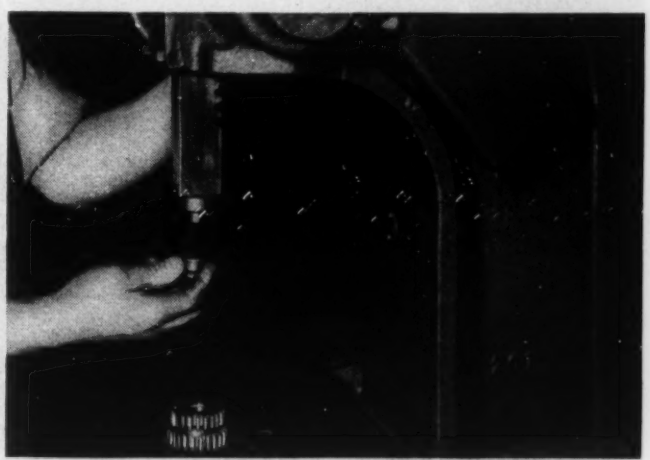
Lifting, lowering and spotting loads is made easy with a P&H Zip-Lift Electric Hoist. Harnischfeger Corporation makes sure that hoist service is reliable, too, with compact, high-capacity Torrington Needle Bearings in the Zip-Lift Drive.



This planetary gear drive incorporates all the best principles of power transmission with a minimum of parts. Needle Bearings provide high radial load capacity in minimum space in the planetary gears. High efficiency is secured with wear practically eliminated.

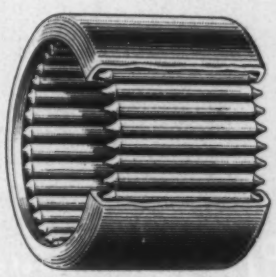


The use of two Needle Bearings per gear gives them unusual stability. The turned-in lips of the bearing shell conserve lubricant. These features keep planetary drive gears running smoothly and quietly with minimum lubrication and maintenance attention.



Installation of the bearings is as simple as the design. They are pressed quickly into place on an arbor press. Both bearings can be installed in one operation with suitable tools. And since Needle Bearings take a firm press fit, no spacers or retainers are needed.

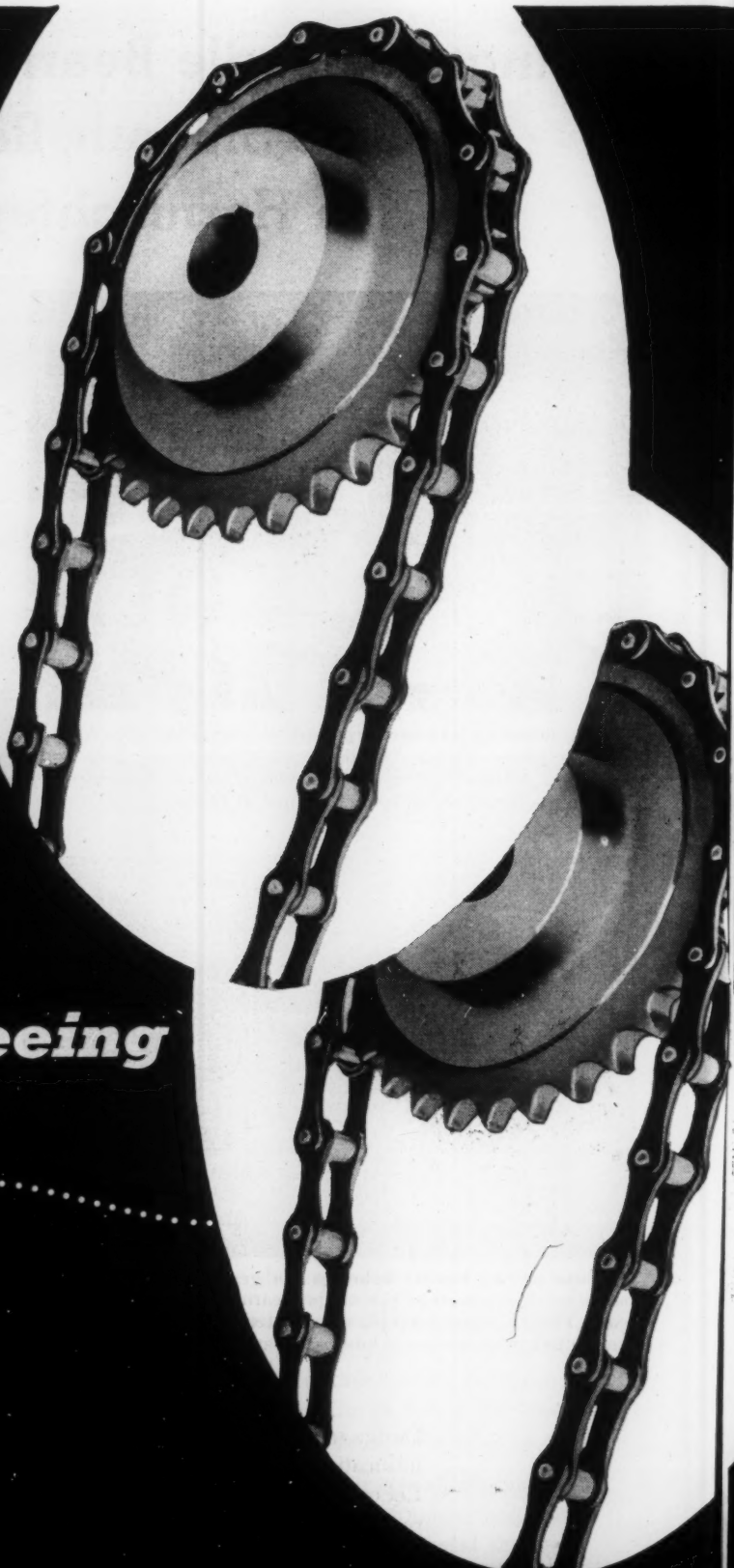
Design *simply* for anti-friction efficiency, high load capacity, effective lubrication and easy installation with Torrington Needle Bearings. Let our engineers combine their experience with yours for profitable results. Write us today. THE TORRINGTON COMPANY, Torrington, Conn., or South Bend 21, Ind. District offices and distributors in principal cities of United States and Canada.



TORRINGTON *NEEDLE* **BEARINGS**

Needle • Spherical Roller • Tapered Roller Straight Roller • Ball • Needle Rollers

Designers are seeing



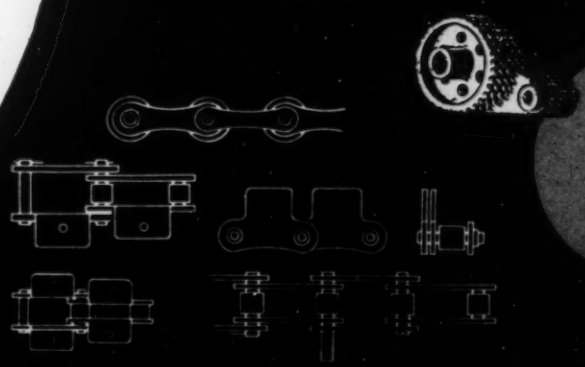
Made of standard roller chain round parts with double pitch side plates.

Weigh less than chains of comparable strength.

Can be used with cast tooth sprockets on many applications.

for lower costs, lighter weight

DOUBLE



Have a full line of standard attachment links and can be furnished with oversize rollers for efficient, smooth conveyor service.

More and more, cost-conscious designers are seeing the advantages of *double pitch* roller chain. For drive or conveyor service, where speeds range from slow to medium . . . loads light to moderate, double pitch chain offers you these important design advantages:

1. CUTS COST. Double pitch roller chain is lower in cost. In many applications, it can be used with cast instead of cut-tooth sprockets for even greater cost reductions.

2. SAVES WEIGHT. For a given strength, double pitch chain is lighter than other type chains.

3. LONG-LIFE EFFICIENCY. Double pitch chain uses standard long-lasting roller chain round parts with side plates of the same material as standard roller chains but double in pitch.

4. UNIFORM WEAR. Correctly applied, parallel strands of double pitch roller chains will wear evenly . . . an important advantage for conveying work.

5. SAVES SPACE. Double pitch roller chain takes up less space . . . permits more compact design.

6. VERSATILITY. Double pitch roller chain operates efficiently on long or short centers.

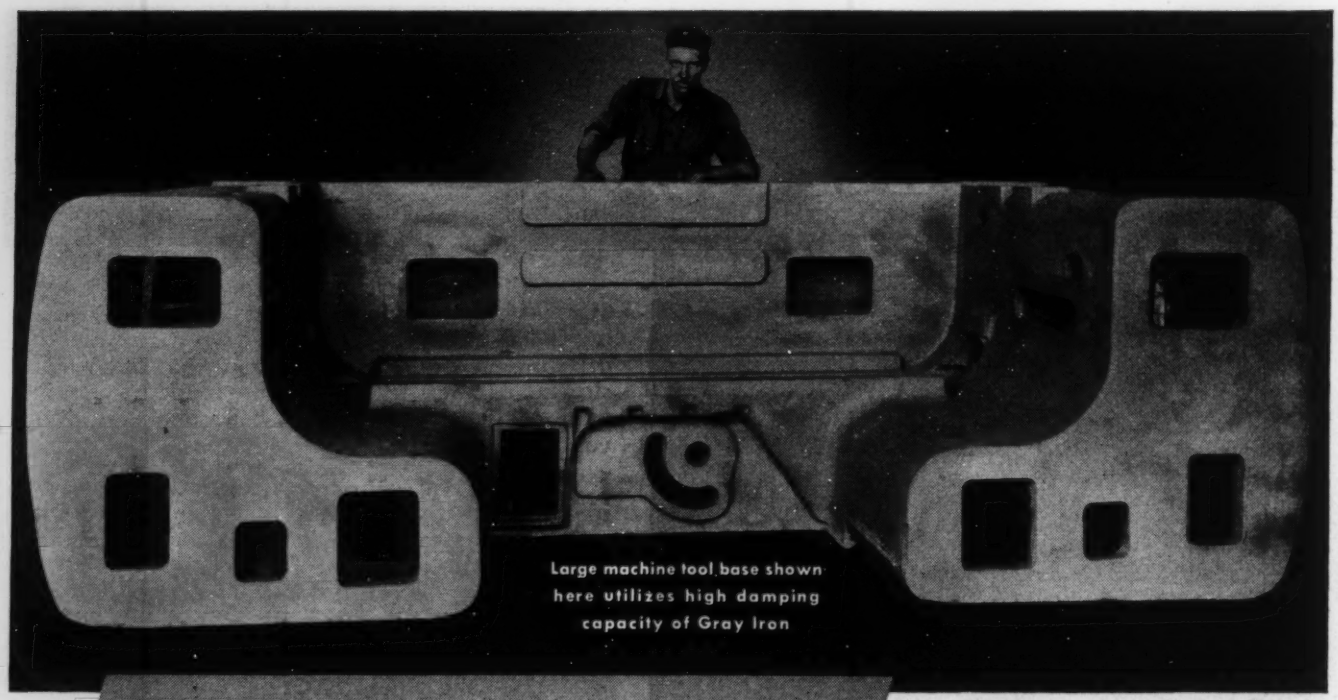
7. OVERSIZE ROLLERS. For efficient, smooth conveyor service, double pitch chain can be furnished with oversize rollers.

Here's a chain that is built to the same exacting standards as standard roller chain . . . that gives you the same basic roller chain features . . . positive power transmission . . . shock-absorbing abilities . . . the ability to drive multiple shafts from a single power source . . . plus its own cost-cutting, weight-reducing advantages.

For all the facts, write Baldwin-Duckworth Division of Chain Belt Company, 320 Plainfield Street, Springfield 2, Massachusetts.

BALDWIN·REX ROLLER CHAINS

A complete line from ¼-inch to 2½-inch pitch
Baldwin-Duckworth Division of Chain Belt Company



Large machine tool base shown here utilizes high damping capacity of Gray Iron

FOR BETTER PERFORMANCE UNDER VIBRATION

Consider These GRAY IRON Characteristics:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Machinability
- VIBRATION ABSORPTION
- Durability
- Wide Strength Range

Write for free booklet, "GRAY IRON—Its Mechanical and Engineering Characteristics, and Details for Designing Cast Components".

Call it Vibration Absorption or call it Damping Capacity—by either name it's a very important consideration in many applications. It makes for quiet operation. Lack of such capacity may result in failure due to critical vibration.

Gray Iron has exceptionally high damping capacity, higher than any of the other common engineering materials . . . up to *ten times* that of any other ferrous metal.

The practical usefulness, therefore, of a part subject to vibration stresses, may be *greater when it is made of Gray Iron* than when it is made of what might commonly be regarded as a much stronger material, but which has *low damping capacity.*

Are you taking full advantage of the unmatched combination of useful properties offered by Gray Iron? Have you considered its ultimate economy?

Make It Better with Gray Iron

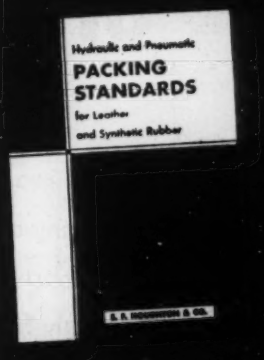
Second largest industry in the metal-working field

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Wichita City Library

...with packing standards



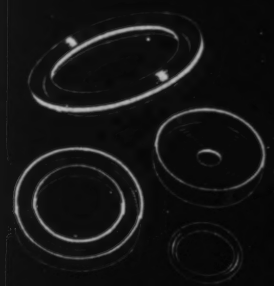
In the movement sponsored by the Joint Industry Conference to set up packing standards, reduce number of sizes and promote interchangeability, Houghton was first to prepare and distribute such simplified standards.

The booklet shown here contains tables of sizes and dash numbers for convenience in ordering. The packing industry generally and the large users have accepted these standards.

AT YOUR SERVICE

That's one valuable aid to industry from this pioneer in hydraulics. Another is the service to designers . . .

...with standard packings



These include leather and synthetic rubber styles —"V", "U", Cup, "O" rings and leather back-up washers.

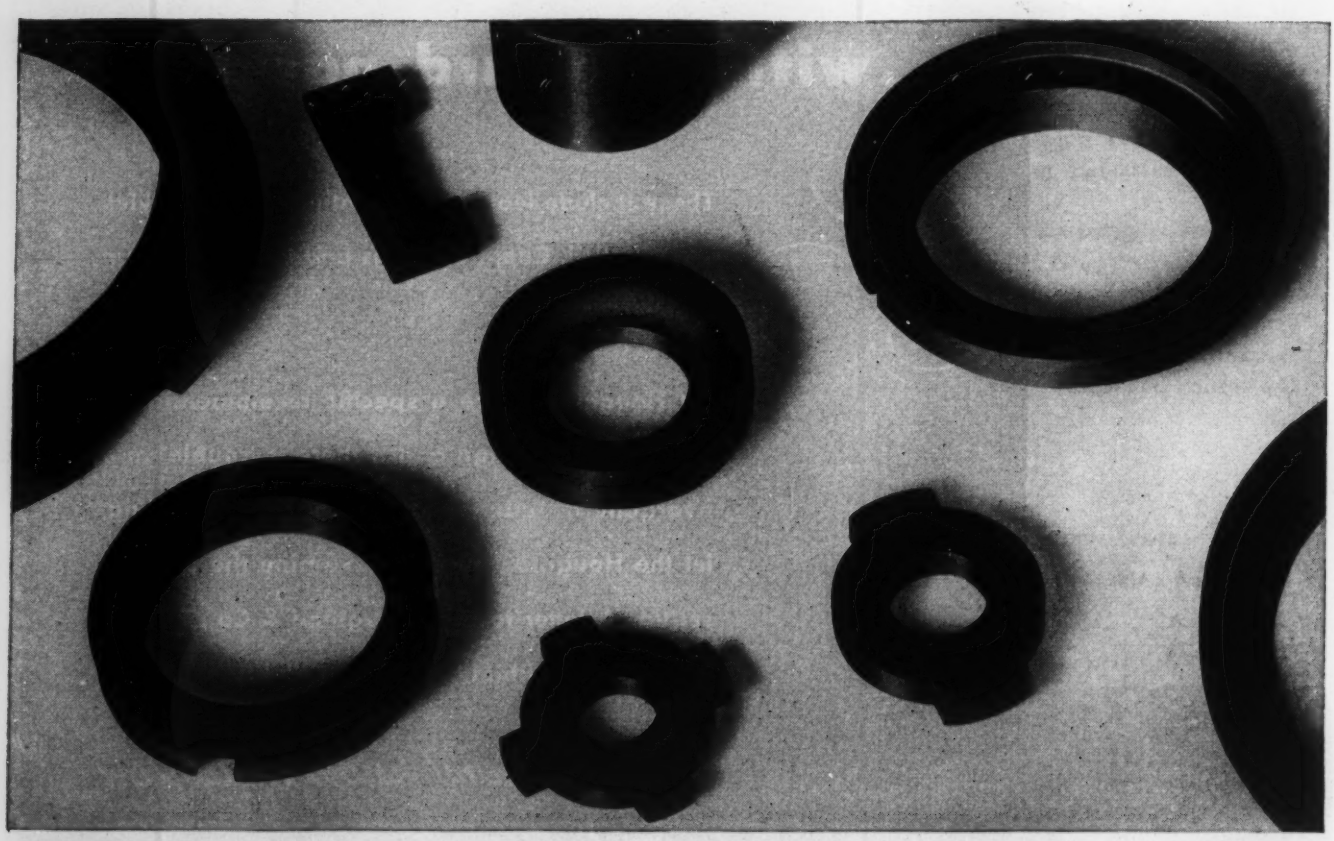
Let Houghton make a specific recommendation on your next design and if there is trouble on a hydraulic installation due to imperfect sealing, let the Houghton engineer examine the packing set-up. A letter to E. F. Houghton & Co., 303 W. Lehigh Ave., Phila. 33, Pa., will bring results.

For "know-how" know Houghton

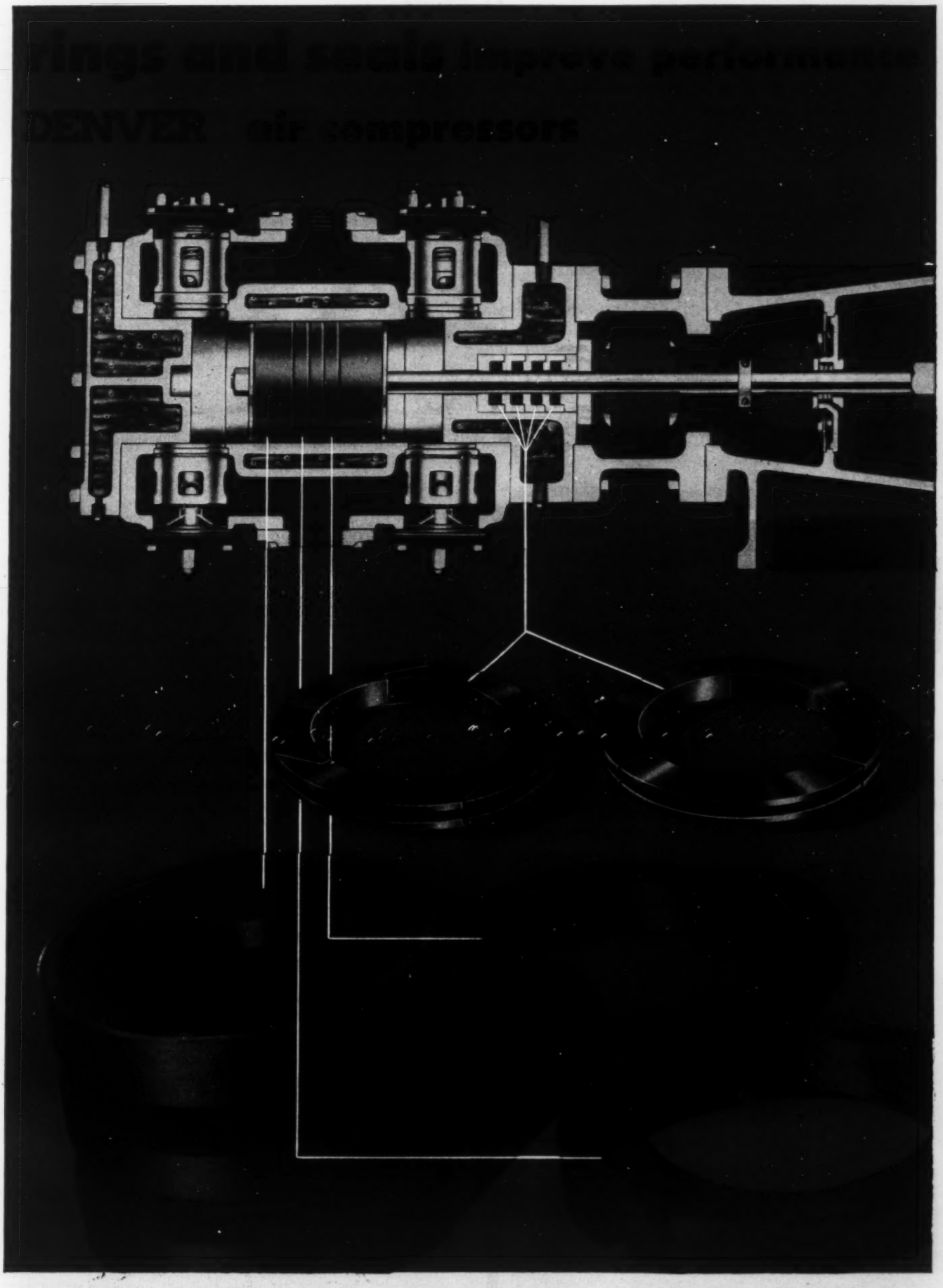
graphitar (Carbon-Graphite) pistons, piston of GARDNER-

The use of Graphitar at vitally important points is one of the reasons for the high operating efficiency and dependability of the Gardner-Denver Company air compressor. Because the piston, piston rings, and piston rod are Graphitar, the compressor needs no lubrication at these points and hence delivers compressed air that is entirely free of oil. Springs seated in grooves machined in the piston expand the Graphitar segmental piston rings to compensate for slight wear, assuring permanent effective sealing. The Graphitar packing rings also are segmented and contract under spring pressure to provide dependable sealing throughout constant use.

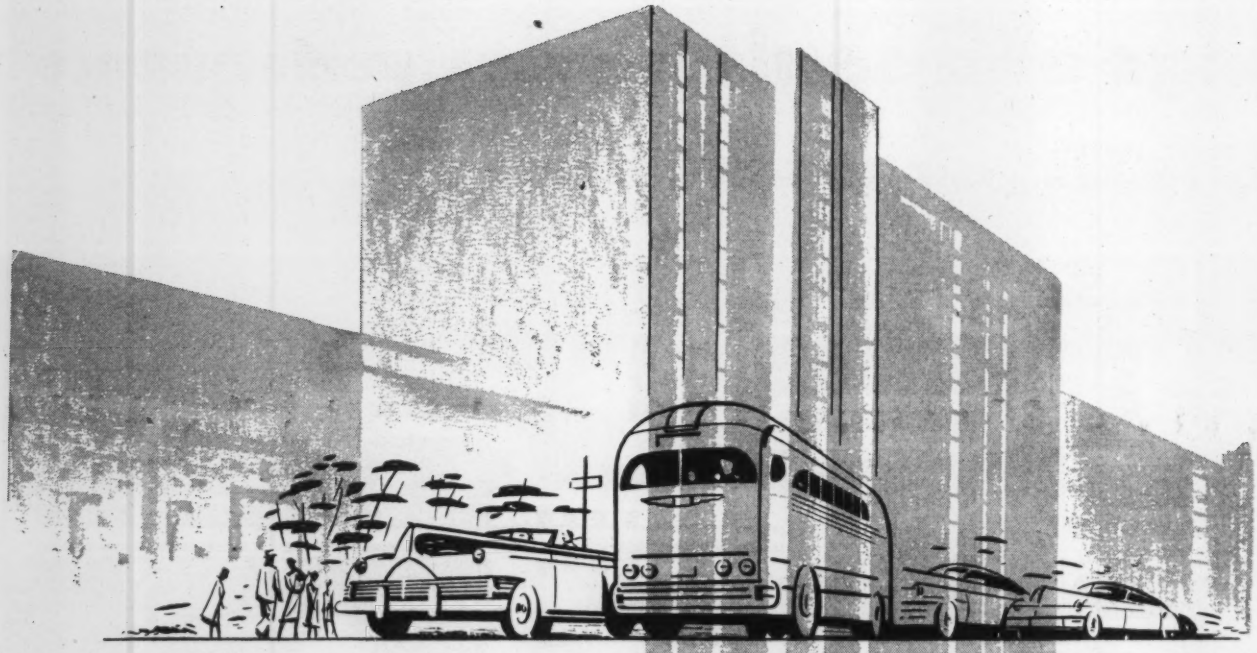
GRAPHITAR IS VERSATILE. Self-lubricating, light-weight, highly resistant to wear, temperature extremes and chemical attack, Graphitar is the ideal material for seals, rings, pistons, cylinder liners, and other parts in a wide variety of mechanisms. We are equipped to produce Graphitar parts in any practical size and shape. Tolerances may be as close as .0005" in small sizes. Send us sketches or descriptions of your products and our engineers will show you where Graphitar parts will improve mechanical performance and save you money. Write for new 64 page catalog just released.



THE UNITED STATES GRAPHITE COMPANY



DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN



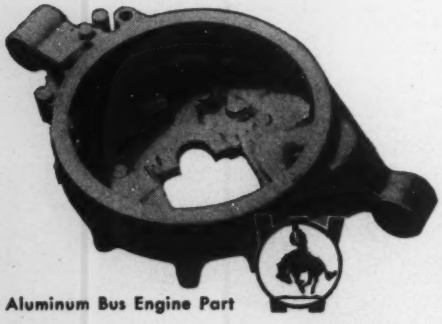
HOW TO TAKE THE LEAD OUT OF A BUS

IT'S a push-over with Well-Cast magnesium and aluminum featherweight castings.

They're tough . . . strong . . . easy to machine. They lower operating costs, make a more saleable product, increase payloads.

Backed by 37 years of practical experience, our engineers can tell you the *right* application for Well-Cast magnesium and aluminum.

Maybe we can take the lead out of YOUR product. Try us. Write for Catalog No. 47.



Aluminum Bus Engine Part

Well Made Patterns, Permanent Mold and Sand Castings

THE WELLMAN BRONZE & ALUMINUM COMPANY

GENERAL OFFICES: 2547 EAST 93rd STREET
CLEVELAND 3, OHIO

CASTINGS X-RAY INSPECTED

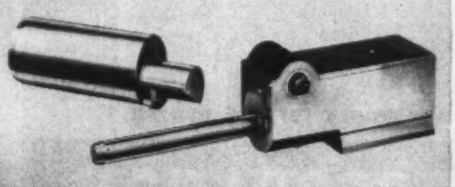
Production gaging with External Comparator No. 951 and Amplifier 950.

with this UNIQUE *Electronic* MEASURING EQUIPMENT

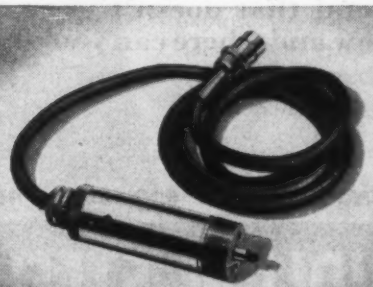
ADVANCED design and construction features make this Brown & Sharpe Measuring Equipment unusually fast, accurate and dependable. Its separate amplifier, for example, completely isolates heat-producing elements . . . thus prevents temperature drift in gaging units. Its true linear response permits accurate setting for the entire scale with only one master block. A single amplifier may be used to serve several separate testing instruments. Line voltage fluctuations within the range of 105 to 125 volts do not affect readings.

These and other advantages make precision gaging on a mass-production basis both practical and economical for any plant or laboratory. Get all the facts about this unique Electronic Measuring Equipment. Write Brown & Sharpe Mfg. Co., Providence 1, R. I., U. S. A.

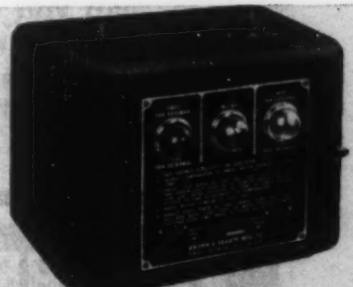
We urge buying through the Distributor



Speedy Internal Gaging from ½" to 2" is provided by Internal Comparator Attachment No. 952. For use with External Comparator No. 951.

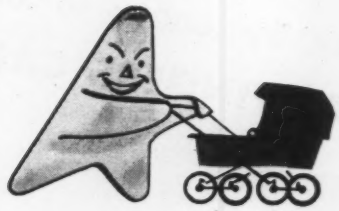


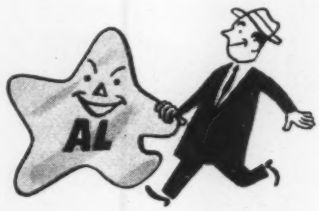
Extremely Accurate Gaging (.0001" to .00001") in stands, jigs and fixtures is offered by Gage Head Cartridge No. 953. Plugs in directly to Amplifier No. 950.



Visual Indication of work conditions show quickly on Signal Light Attachment No. 958. For use with Amplifier No. 950. Easily attached.

BROWN & SHARPE

How long 

<u>is</u> a lifetime 

in Stainless Steel?

We call Allegheny Metal "the time-tested stainless steel" because it's the pioneer in America, but time hasn't really tested it yet. Neither we nor anyone else knows how long stainless steel will last. The earliest installations of Allegheny Metal—made more than 20 years ago—are just as bright, strong and resistant as when new. How can you defeat a metal that doesn't wear out and can't wear off? • More important, how and where can you *use* it to advantage, *today?*

W&D 2175

Complete technical and fabricating data—engineering help, too—yours for the asking.

ALLEGHENY LUDLUM STEEL CORPORATION

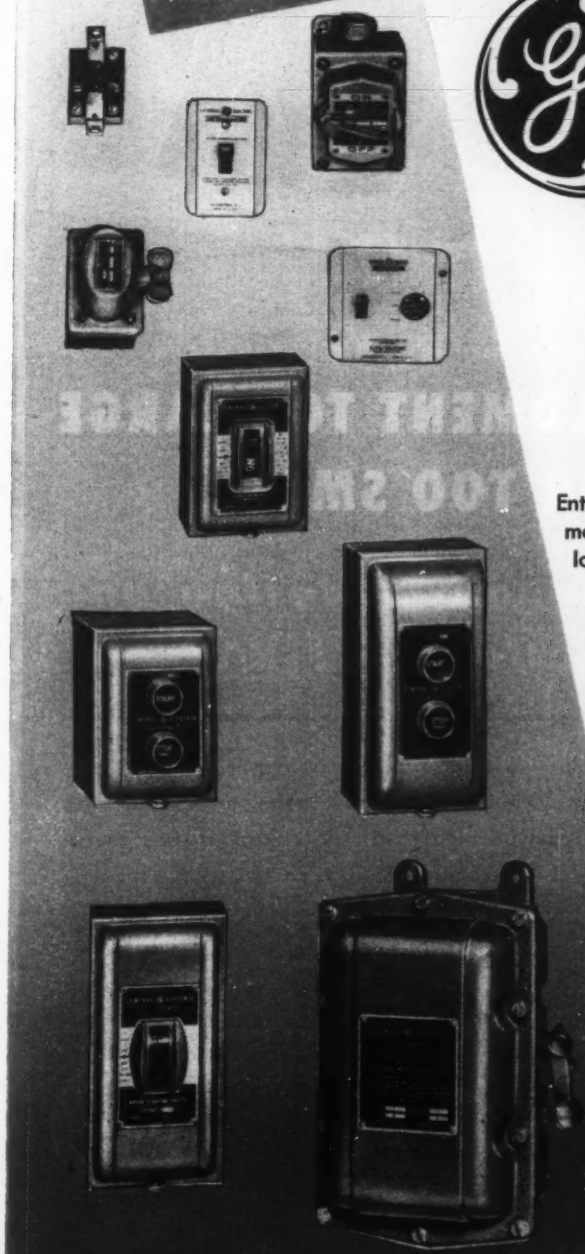
The Nation's Leading Producer of Stainless Steel in All Forms

AL

Pittsburgh, Penna. . . . Offices in Principal Cities

Allegheny Metal is stocked by all Jos. T. Ryerson & Son, Inc., Warehouses

more for your money



NEW manual motor starters

- **new, improved features**
- **wider selection**

Entire line of G-E manual starters—for fractional up to 7½ horsepower motors—now offers new design features that mean easier installation, longer operation at no increase in price. Here they are:

A complete new line of pushbutton starters for controlling integral motors. Both pushbutton- and toggle-operated starters are available in the new four-pole form as well as the two- and three-pole forms previously offered.

Bi-metallic overload protection—formerly found only in expensive equipment—provides quick, positive action, frequent resetting without wear. When relay trips, operating mechanism assumes neutral position, giving positive indication of overload trip.

All starters provide . . .

● ● ● heavy duty switch mechanism that resists vibration, stands up under frequent use . . . plenty of knockouts, lots of room in the sturdy grey case for wiring . . . dust tight, water tight, and explosion-proof as well as general purpose forms . . . and many other features described in the bulletins.

Whatever your requirements for small-motor starting, you'll find them met in G-E manual starters. Write now—buy now!

General Electric Company
Apparatus Dept., Section C730-8
Schenectady 5, N. Y.

Please send me: Bulletin GEA-2234E on the CR1061 Manual Starter for F-hp motors.....and (or) Bulletin GEA-1522E on the CR-1062 Manual Starter for Integral Motors.

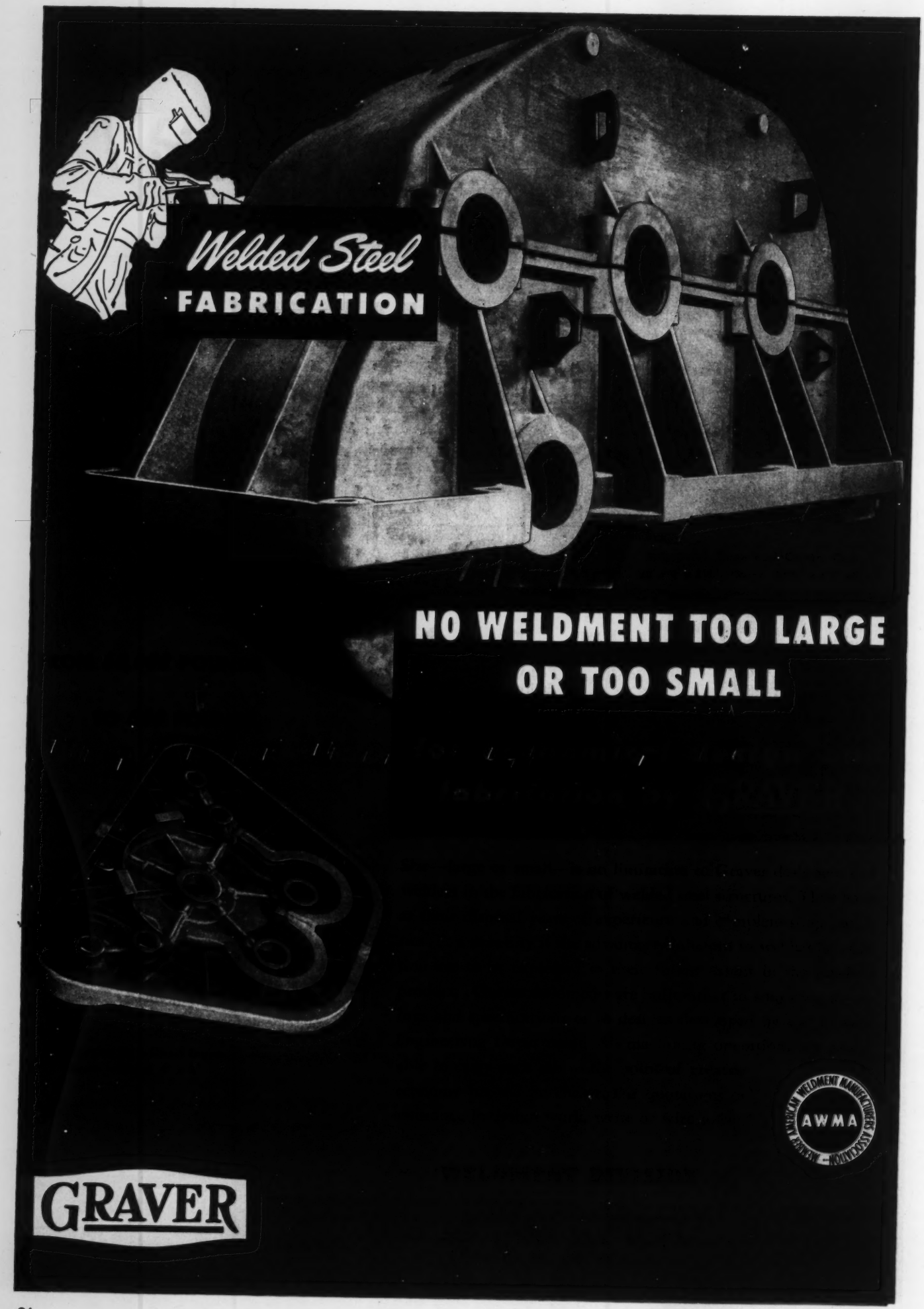
Name.....

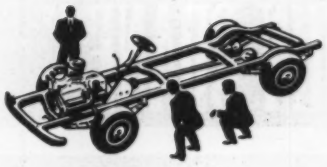
Company.....

Address.....

.....

GENERAL ELECTRIC


Welded Steel
FABRICATION
NO WELDMENT TOO LARGE
OR TOO SMALL
AWMA
GRAVER



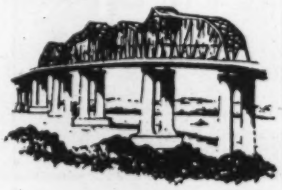
The testing device of a *thousand uses*

PRODUCT IMPROVEMENT

The Automotive Industry uses the SR-4 to check stresses and strains in vital parts, eliminate weaknesses, improve the product.

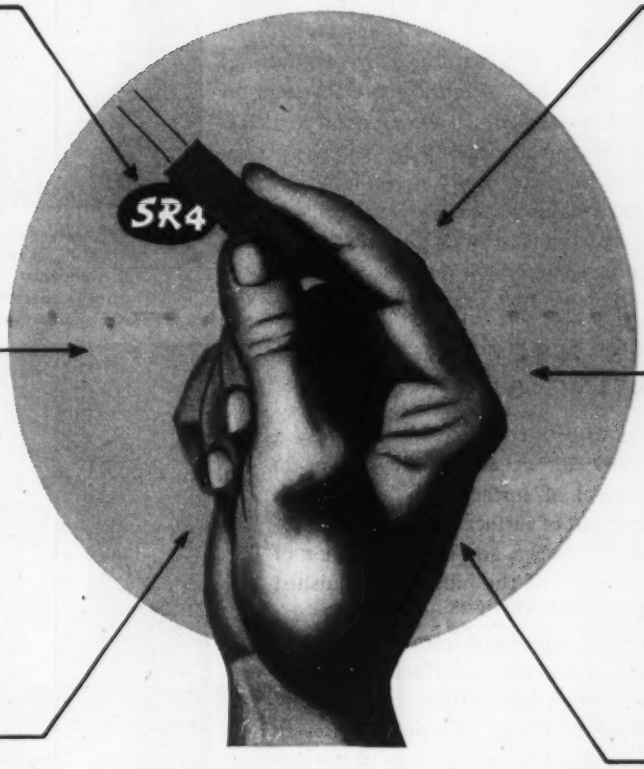
AIRCRAFT LIGHTENING

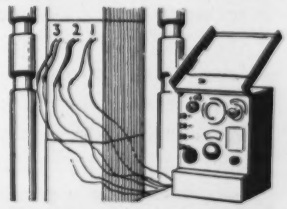
The Aircraft Industry uses the SR-4 to plot the complex flow of stresses in aircraft wings during flight, "balance" the design.



STRUCTURAL STRESS ANALYSIS

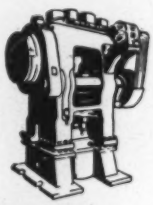
Engineering organizations check theoretical stress distribution against actual patterns, to verify design practice.





MASONRY STRESS DETERMINATION

The heavy construction industry is learning valuable new facts on how masonry withstands loading . . . with the SR-4.



MACHINE REDESIGN

Equipment manufacturers use the SR-4 to isolate the cause of puzzling breakages and to point the way to a correct solution.

MAKING BALLISTICS STUDIES

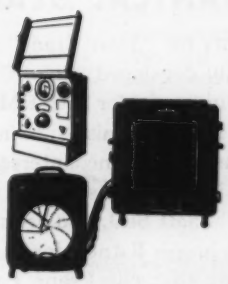
The flow of stress in a gun barrel as the bullet passed through was once a matter of theory... but a matter of accurate knowledge now, because of the SR-4.

BALDWIN SR4* STRAIN GAGE

It's hard to believe—yet this one little testing device, no larger than a postage stamp, has done more to broaden engineering knowledge through product analysis than all other testing equipment combined:

It has provided—for the first time—an accurate picture of actual stress distribution in such structural, equipment and machine parts as an airplane wing in flight . . . the interior of a mammoth masonry dam . . . the barrel of a cannon when the shell flashes from breech to muzzle . . . the frame of a punch press . . . the connecting rods of diesel engines during operation. In every instance, the new knowledge it revealed has permitted engineers to better the design job.

The long list of successful uses does not define the ultimate applications of the Baldwin SR-4 strain gage, but merely indicates its almost limitless possibilities. If you have any problem where unexplainable failures of parts are puzzling you . . . where some equipment must be lightened while retaining balanced strength . . . where a complete report of actual stress distribution in a structure will aid you in design . . . the Baldwin SR-4 can undoubtedly help you, as it has helped many others.



A comprehensive line of indicating, recording and switching instruments and equipment is available for both laboratory and field studies. The units illustrated include an SR-4 Strain Recorder Chart, and SR-4 Portable Strain Indicator, and an SR-4 Switching Unit, with which 48 strain gages can be switched in and out of service in as little as 50 seconds. These are only a few of many.

ASK FOR LITERATURE. Informative Technical Bulletins give a concise technical description of the SR-4 and collateral equipment. Ask for copies, indicating the type of testing in which you are interested.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Boston, Chicago, Cleveland, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Seattle, St. Louis, Washington. In Canada: Peacock Brothers, Ltd., Montreal, Quebec.

*T. M. Reg. U. S. Pat. Off.

TESTING HEADQUARTERS

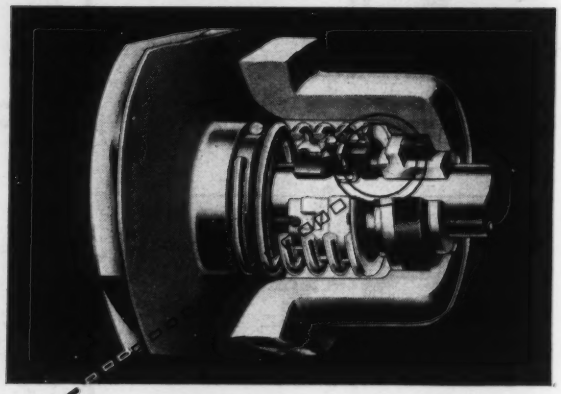
BALDWIN

FACTORS IN SHAFT SEAL DESIGN by "JOHN CRANE"

THE REASON WHY PRECISION SURFACES ON MATING FACES ARE IMPORTANT TO SHAFT SEAL OPERATION

Condition of the sealing faces often spells the difference between long life and early failure of the modern mechanical seal. Today's high speeds and pressures make precision-flat mating surfaces a definite necessity for successful seal operation.

Actual sealing in the mechanical seal is performed by two mating faces which are separated by a thin film of lubricant. Uneveness or scratches on either surface create openings which allow foreign particles in the sealed liquid to work in between the faces. Such particles act as abrasives, and by causing excessive wear, result in seal failure. Ordinary machining or grinding forms surfaces which do not keep abrasive particles away from the area between the faces. *Only by precision lapping can surfaces be generated which are flat and smooth enough to form a film of sufficient thinness to exclude them.*

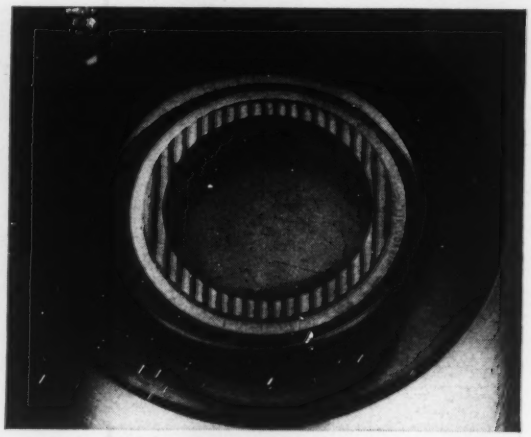


Cut-away view of the "John Crane" Type 2 Shaft Seal. Note, in circle, mating faces of sealing washer and stationary floating seat. Precision lapping to micro-inch specifications and optical flatness requirements insures top performance under high pressures.

TWO OBJECTIVES NECESSARY FOR PERFECT MATING SURFACES

There are two main objectives to be met in the production of a good mating surface, and both can be attained by precision lapping. The first is the removal of surface hills and valleys (scratches and flaws). Measurement of surface finish according to this specification is made in micro-inches, and is an indication of the depth of the valleys and height of the hills of the finished surface. It is known as RMS.

The second objective, extremely important from the mechanical seal standpoint, is flatness of the whole surface area. Such surface measurement is made through optical flats—and in many cases mechanical seal faces must be flat to 11.6 millionth of an inch, which is equivalent to one light band. An idea of the difference between a precision lapped surface and an ordinary ground surface can be gained from the fact that light bands cannot be seen on the relatively rough, ground surfaces.

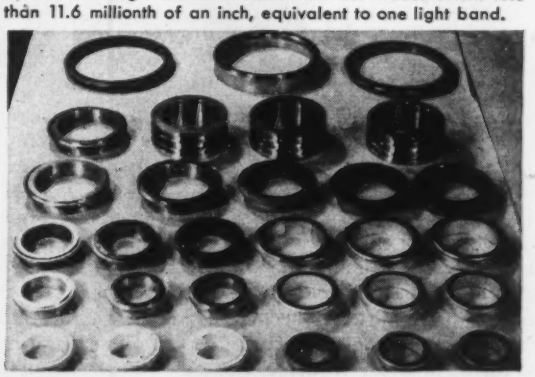


Floating Seat for "John Crane" Shaft Seal, viewed under an optical flat. Light bands indicate flatness measurement less than 11.6 millionth of an inch, equivalent to one light band.

PRECISION LAPPED FINISH FOR ALL JOHN CRANE MECHANICAL SEALS

All sealing washers and floating seats for "John Crane" Shaft Seals are precision lapped on specially developed "John Crane" Lapmaster machines, and are rigidly inspected for both RMS and Optical Flatness Measurement. The precision finish specification for each seal depends on the pressures to be encountered. The higher the pressures, the more rigid is the finish specification.

When you specify a "John Crane" Shaft Seal, you are sure of the finest quality surface finish—of a proper flatness for your application. And, you can also be sure that the Crane Packing Company's wide experience in all types of sealing problems will be at your complete disposal. Contact your nearest Crane Packing Company office the next time a sealing need arises.



Shaft Seal floating seats just lapped by "John Crane" Lapmaster machines. Materials shown include: Stainless Steel, Stellite, Ni-Resist, Bronze, Brass, Cast Iron, Fansteel, Carboloy, Ceramic and Carbon.

Write for the latest free bulletin describing "John Crane" Shaft Seals.

Dept. M9, 1825 Cuyler Avenue • Chicago 13, Illinois

JOHN CRANE

PACKINGS AND MECHANICAL SEALS

CRANE PACKING COMPANY

CHICAGO

Offices in All Principal Cities in United States and Canada

TRADE JOHN CRANE MARK

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

NEW!

Positive Low-Cost Motor Protection

These new Westinghouse Manual Motor Sentinels (motor starting and overload protection) are available in three types: the Standard (Nema type 1), the Water- and Dust-tight (Nema types 3, 4 and 5), the Explosion-proof (Nema types 7 and 9). These compact, handsomely styled switches start, stop and give positive protection to all motors up to one hp wherever they may be located.

Sensitive, automatic bimetallic element will pass momentary overloads and starting surges, but a dangerous overload will trip the switch immediately to disconnect the motor from the line and save it from damage. Examine these rugged new switches at your nearby Westinghouse distributor or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-30007

EXTRA VALUE FEATURES

POSITIVE ACTION—Bimetallic overload protection assures safe, positive action under serious overloads.

SAFE—No exposed parts. Trip-free switch (can't be held closed against an overload) with self-indicating operating handle.

TROUBLE-FREE—Over-center toggle mechanism . . . quick-make, quick-break, double-break contacts of high-grade silver for long contact life.

ACCESSIBLE—Heaters removable from the front without disturbing any wiring. Switch always remains mounted.

CONVENIENT—Switch unit fits any standard wall box. Straight-through wiring—all terminals are on the front.

ATTRACTIVE—Sleek, hot-molded switch unit. Standard enclosure is smooth die-casting, baked enamel over Bonderizing. Watertight and explosion-proof enclosures are sturdy cast iron.

WESTINGHOUSE

MANUAL MOTOR STARTERS

no more hand-me-downs

for stainless sheet and strip

Stainless sheet and strip production is coming of age—no longer made on the hand-me-downs of carbon steel production, thanks to modern advances in strip mill practice. CRUCIBLE, drawing on this progress and on generations of *specialty* experience, has carried stainless development even further by building the world's first complete mill designed *specifically* for hot and cold rolling of stainless steels. In this $18,000,000 project, every building, every piece of equipment, has been built to incorporate the *best* of accepted modern practice, PLUS exclusive features designed by CRUCIBLE's industry-famous technical staff.

Here stainless sheet and strip is produced in widths from ½″ to 50″ inclusive, in all gauges, grades and finishes. This new and important contribution to the production of stainless steel is vital news to every processor of stainless steel products. For now CRUCIBLE, one of the pioneers in stainless steels, rounds out an integrated program of stainless in all its forms—sheets, strip, plates, bars, wire, forgings, castings, and tubing (manufactured by the new subsidiary, Trent Tube Co.) To this program CRUCIBLE has applied its *specialty product* methods of quality control, methods that have given CRUCIBLE leadership in special purpose steels for half a century. Data sheets for all grades are yours for the asking. Your inquiries will be welcomed.

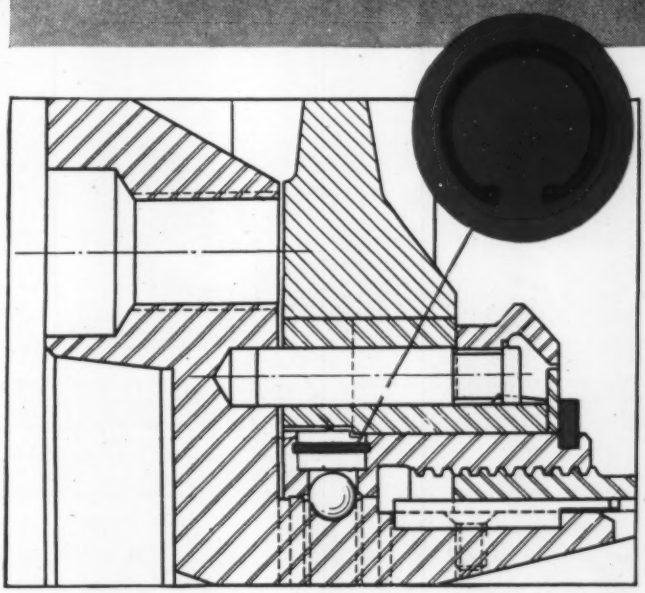
CRUCIBLE STEEL COMPANY OF AMERICA
405 Lexington Ave., New York 17, N. Y.
Branches, Warehouses and Distributors in Principal Cities

CRUCIBLE first name in special purpose steels

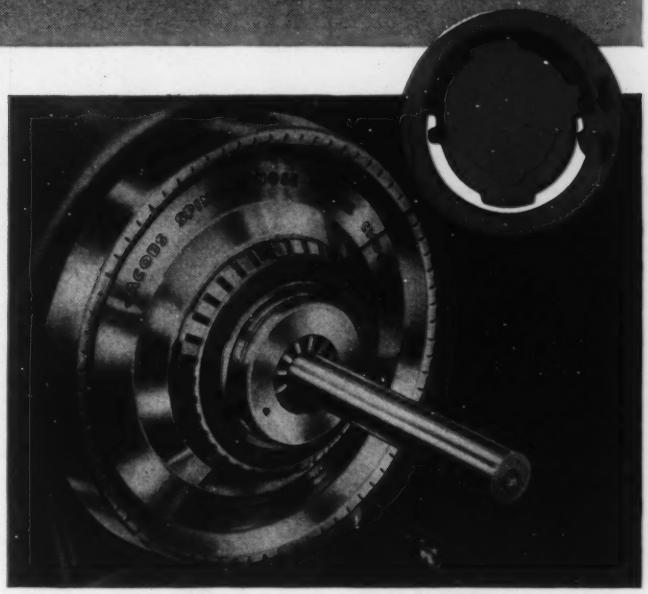
hot and cold rolled **STAINLESS SHEET AND STRIP**

STAINLESS • HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE • STEELS

2 Waldes Truarc Rings Save Space ...cut costs...Lock entire chuck



INTERNAL RING: Used instead of a shoulder screw, Truarc internal ring #5000-37 locks disc over ball loading hole. Saves 1/8 inch in overall diameter. Eliminates tapping. Withstands machine vibration and vibration from impact device within chuck. Used with Truarc pliers, it facilitates assembly and disassembly.



INTERLOCKING RING: Used instead of a locknut, Truarc interlocking ring #5107-343 locks handwheel assembly securely on impact sleeve of Jacobs chuck. Saves 7/32 inch in overall length. Eliminates tapping. Chuck's top speed: 5000 RPM; Truarc ring is dynamically balanced to withstand 50,000 RPM's. Services easily with a screwdriver.

2 Waldes Truarc Retaining Rings secure the entire mechanism of new spindle nose lathe chuck for Jacobs Mfg. Co., Hartford, Conn. Truarc gives Jacobs a finer, more compact product, and at lower cost than possible with any other fastening device.

Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your drawings to Waldes Truarc Engineers for individual attention, without obligation.

2 TRUARC RINGS GIVE 6 BIG ADVANTAGES

- Cut overall length 7/32 in.
- Cut overall diameter 1/8 in.
- Eliminate cost of tapping
- Withstand up to 50,000 RPM's, give a factor of assurance of 10
- Withstand machine vibration
- Facilitate assembly, disassembly

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,302,948; 2,026,454; 2,416,882 AND OTHER PATS. PEND.

MD-91

Waldes Kohinoor, Inc., 47-16 Austel Place
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

Name_____

Title_____

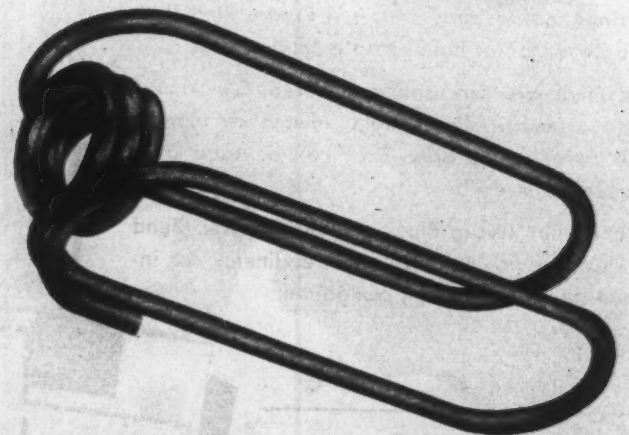
Company_____

Business Address_____

City_____ Zone_____ State_____ ★

LOOKING FOR A NEW

Twist?



Wallace Barnes Springs

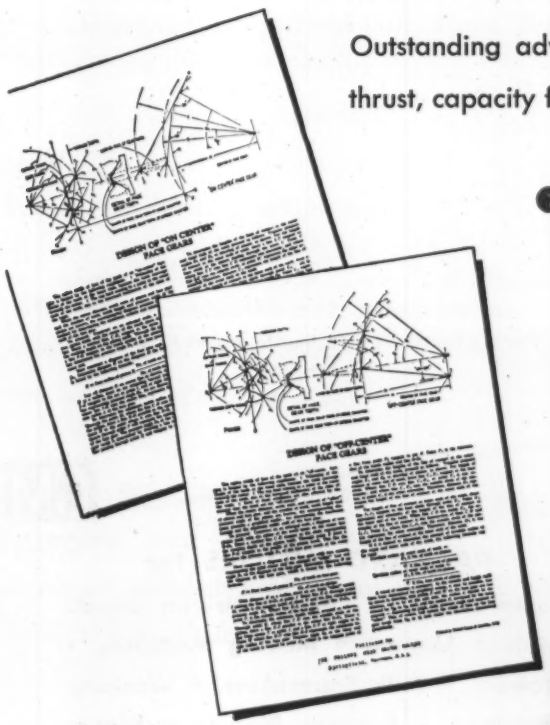
Bristol Connecticut

FACE GEARS

Design Solution to ANGULAR DRIVES

The face gear offers inviting possibilities to the designer for 90° and other angular drives. Both face gear and pinion can be produced with high accuracy on the Gear Shaper—and at costs so low as to invite designers to prefer this type of gear for many angular drives.

Outstanding advantages are: more compact design, no appreciable thrust, capacity for high speed, and low cost of production.



● Instructions for Designing Face Gears

These new data sheets explain a simplified procedure for determining the active face width for "on-center" and "off-center" face gears. Copies can be obtained by writing our nearest office. A special bulletin of principles and applications of face gears is also available.

Fellows

THE FELLOWS GEAR SHAPER COMPANY
Head Office and Export Dept., Springfield, Vermont. Branch Offices: 616 Fisher Bldg., Detroit 2; 640 West Town Office Bldg., Chicago 12; 7706 Empire State Bldg., New York 1.

GEAR SHAPERS • THREAD GENERATORS • CUTTERS • SHAVING AND BURNISHING MACHINES
GEAR MEASURING AND INSPECTION INSTRUMENTS • PLASTICS MOLDING MACHINES

PACKARD SUNLIGHT MOTORS

Built by fractional horsepower motor Specialists

Packard *specializes* exclusively in the manufacture of fractional horsepower motors. Our entire enlarged plant facilities . . . all of our engineering and manufacturing experience . . . are concentrated in this single field. Manufacturers of motor-driven appliances and equipment have long profited from this singleness of purpose. Packard Fractional Horsepower Motors are of outstandingly uniform quality . . . can be delivered in greater quantities in less time. For fast action on your fractional horsepower motor problem, specify Packard motors—engineered and built for lasting satisfaction.

Packard
REG. U. S. PAT. OFF.
TRADE MARK

Packard Electric Division, General Motors Corporation
Warren, Ohio

GM
GENERAL MOTORS

PACKARD MOTORS for

Compressors • Power-driven Bench Tools • Ironers • Milking Machines • Stokers • Milk Separators • Washing Machines • Furnace Blower • Water Pumps • Oil Burners • Ventilators and many other applications

ORS FOR THIRTY-TWO YEARS

Wichita City Library

Further Information?

IF YOU DESIRE MORE INFORMATION ON ANY ADVERTISEMENT IN THIS ISSUE

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Write the name of the advertiser and the page number of the ad in the spaces provided on the card. Check the type of information you want—whether it has to do with price, where you can buy it, or more needed details—or all three, if you wish. After you have finished going through MACHINE DESIGN and have jotted down all the ads on which you'd like more information, just tear off the card and drop it in the mail. No postage is required. We'll have our staff forward this information immediately to the advertiser, so that you will be relieved of the necessity of writing a number of letters. You will then hear directly from the advertiser, answering your request. Because we know that MACHINE DESIGN gets around, and that more than one person sees your copy, we have made up three cards so that if you are one of the later readers, you can still have the opportunity of taking advantage of this service.

Please send further information on the following advertisements in this issue:

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		○	○	○
		○	○	○
		○	○	○
		○	○	○

YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MD9-49

FIRST CLASS
PERMIT No. 36
(Sec. 510 P.L.&R.)
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BUSINESS REPLY CARD
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MACHINE DESIGN
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Cleveland 13, Ohio

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EMC
FRACTIONAL H.P. MOTOR PARTS SETS

for Products with Component Motors

Now you can get EMC Motor Parts Sets consisting of brushes, brush holders, armatures and fields in all ratings up to 1/2 h.p.—all manufactured by the producers of EMC Motors, justly famous for outstanding "power zone" service in hundreds of different products. The *extra service* you "build in" with EMC *Motor Parts Sets* helps maintain your reputation for smooth-running, long-lasting products. Write for the complete details.

EMC Specification Sheet Saves You Time

The EMC specification sheet simplifies listing facts about your product, which can be fitted with a custom-designed EMC Motor if its power requirements come within the range of 1/2000 h.p. up to 1/2 h.p. Write for your copy.

TRADEMARK EMC REGISTERED

CUSTOM-BUILT FRACTIONAL H.P. MOTORS FOR ALL INDUSTRY

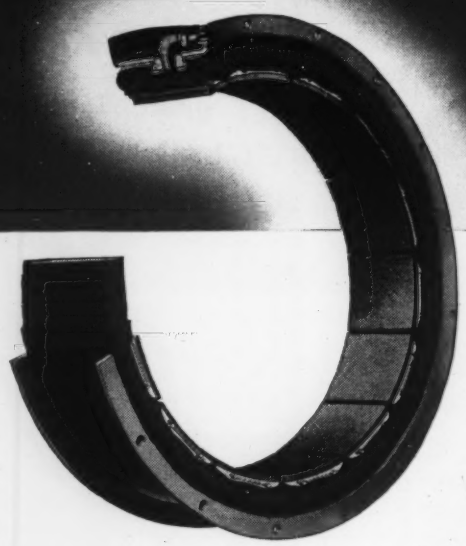
ELECTRIC MOTOR CORPORATION

Division Howard Industries, Inc.

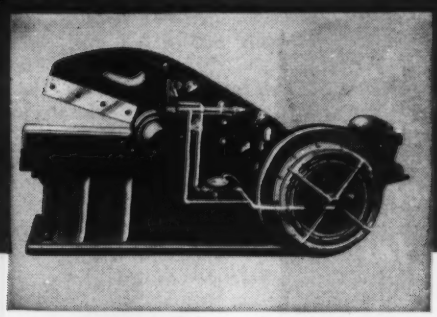
RACINE • WISCONSIN

ONLY ONE MOVING PART

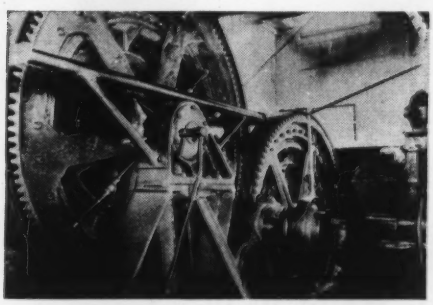
in this Fawick Clutch



Fawick Airflex Clutch or Brake Type CB



Fawick Airflex Clutch and Fawick Air-Ring Brake on Canton 11A Shears made by Hill Acme Co., Cleveland, Ohio.



2 Fawick Airflex elements used for hoist drum and drag drum clutches on Marion Model 350 Dragline.

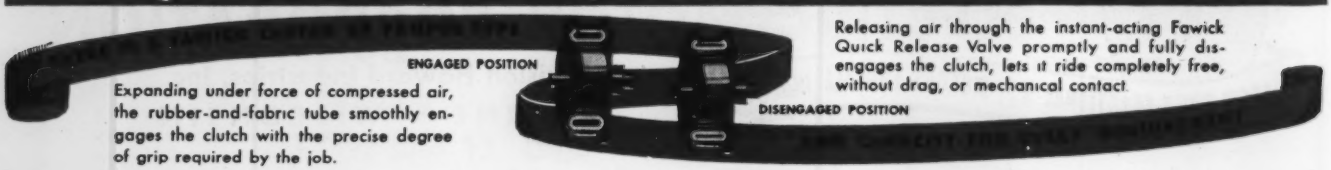
Fawick Airflex Clutch and Brake on two Farrel Birmingham 18 x 50 Mills at Goodyear Rubber Sundries Co., New Haven, Connecticut.

The rubber-and-fabric pneumatic tube faced with friction shoe assemblies is the only moving part in this Fawick Clutch. This part naturally stays in perfect adjustment at all times—automatically compensating for wear of the friction shoes.

Job-tested, Fawick Clutches meet the toughest operating conditions in many fields—petroleum, earth-moving, metalworking, rubber, paper, pulp and others.

Write our engineering department for a recommendation of the Fawick elements best suited for your machines. Address Dept. MD.

FAWICK Airflex CO., INC.
9919 CLINTON ROAD CLEVELAND 11, OHIO



ENGAGED POSITION

Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

DISENGAGED POSITION

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact.

HOW TO SOLVE HIGH TEMPERATURE PROBLEMS

Appliance designers agree that most high-temperature problems fall into two broad classifications . . . (1) where operating temperatures range up to 650°F. (2) where they exceed 1000°F.

In the 400° to 650° range, commonly experienced troubles are spring relaxation and corrosion. At higher temperatures, destructive oxidation, embrittlement, and heat-softening become serious threats.

Many prominent manufacturers have found that *both* high and low heat problems can be solved dependably with the versatile Inco Nickel Alloys. Each of these individualized "task metals" offers special advantages *in addition* to remarkable resistance to corrosion and destructive oxidation.

*Monel**, with the strength of structural steel, withstands temperatures of 1000°F. *"K"** *Monel* offers greater hardness through heat-treatability. *Inconel** withstands temperatures up to 2000°F., and is relatively unaffected by corrosive atmospheres that rapidly destroy ordinary metals.

Still other Inco Nickel Alloys . . . "R"* Monel, "KR"* Monel, Duranickel*, Permanickel* . . . offer special properties that help electrical manufacturers solve difficult design problems.

If you would like to see how other manufacturers are using Inco Nickel Alloys to improve their products, write for *"66 Practical Ideas for Metal Problems in Electrical Products."* This lavishly illustrated 36-page booklet may suggest a solution to some of your own engineering and manufacturing problems. Send for it . . . today.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.

*Reg. U. S. Pat. Off.

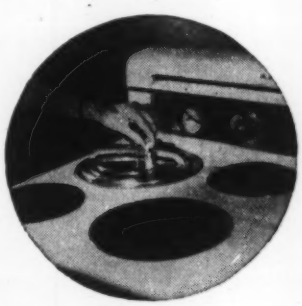
TUBING THAT RESISTS HEAT

Steam iron tubing calls for easy-to-form, rustproof metal . . . resistant to oxidation at operating temperatures up to 550°F. McCracken and Daniels Co., makers of steam-electric irons, found that rustless, corrosion-resistant "L" Nickel tubing (¼"O.D.x.028" wall) provides essential hot strength and may be cast right into the sole plate without warping or collapsing.

In many other makes of irons a difficult high temperature problem—thermostat springs—is solved by use of Inconel.

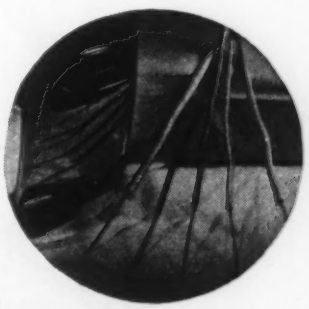
CONNECTORS THAT STAY TIGHT

Appliances fitted with these solid Nickel heat-resistant connectors, face no danger of oxidation, embrittlement or softening when operating at 1900°F. Produced by Thomas & Betts Co., Inc., these connectors are permanently affixed to flat ribbon, solid round or stranded wires by the tool shown.



HEATING UNITS THAT LAST

Hundreds of thousands of Inconel sheathed heating-units are in use today. Many have been on the job for 10 years—and longer. Inconel sheaths resist corrosion from spill-overs, and remain free from warping, scaling and cracking. Inconel gives much longer life than material used on earlier units. That's why range manufacturers standardize on Inconel for sheathing.



FEWER LEAD WIRE BURN-OUTS

Stop customer complaints and dealer dissatisfaction . . . by using lead wires that resist oxidation and high-temperature deterioration. Appliance makers use nickel wires, made by Rockbestos Products Corporation, to assure trouble-free service and excellent conductivity.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

Monel • "K" Monel • "R" Monel • "KR" Monel • "S" Monel • Nickel • "D" Nickel • "L" Nickel • Duranickel • Permanickel • Inconel • Inconel "X"

Piasecki Helicopter Uses

NORMA-HOFFMANN EXTRA LIGHT SERIES BEARINGS

to meet space limitations and provide top performance

Built for the Navy, the Piasecki XHJP-1 seven place tandem rotor helicopter with an engine power of 525 hp recently set an unofficial world's speed record of 131 mph for this type of plane. In addition, it is the first helicopter known to have performed a loop. These are two records to be proud of as they prove the worthiness and structural fitness of the plane.

Piasecki Engineers, like many other engineers, chose *Norma-Hoffmann XLS and RXLS extra light series bearings* in the clutch and rotor transmission respectively for "suitability of size plus performance."

Having unusually large bores compared to outside diameters, Norma-Hoffmann *Extra Light Series XLS and RXLS Bearings* offer engineers and designers the advantages of compactness, light weight and ruggedness plus high anti-friction efficiency. In many cases these *extra light series bearings* provide the only solution where space is restricted.

Whether you build planes, automobiles, machine tools or other equipment, it will pay you to investigate *Norma-Hoffmann Extra Light Series Bearings.* They are available in ranges from ¼" to 22½" bore. Our Field Engineers will gladly help you with your bearing problems. Write for their assistance and catalog.

NORMA-HOFFMANN *Precision* **BEARINGS**

BALL · ROLLER · THRUST

NORMA-HOFFMANN BEARINGS CORPORATION
STAMFORD, CONN.

Field Offices: New York · Chicago · Cleveland · Detroit · Cincinnati
Los Angeles · San Francisco · Dallas · Seattle · Phoenix

N

W

E

"Change course—aye, aye, sir!"

In today's highly competitive appliance market, it's not always possible for a manufacturer to hold to the course of action and product specifications originally plotted.

Very often after he places an order with a supplier, unforeseen developments pop up to necessitate changes in design or quantity. Frequently schedules must be modified on short notice to meet new requirements.

So, as part of developing an organization that places customer satisfaction above all else, Delco Products has acquired the faculty of working under pressure to take care of last minute changes in specifications and schedules.

It's this flexibility—together with modern facilities, sound experience, and a thorough appreciation of all problems confronting a manufacturer—that makes Delco Products first choice of those who need quality appliance motors in volume.

DELCO PRODUCTS DAYTON, OHIO

DELCO MOTORS

DELCO PRODUCTS

Division of General Motors Corporation, Dayton, Ohio

Sales Offices: CHICAGO • CINCINNATI • CLEVELAND • DETROIT • HARTFORD

Highest Qualifications

for

Meeting Rigid Demands

The remarkably wide range of uses to which components made and processed by Western Felt are astonishing. It is serving in scores of industries—from women's hats to 50 ton forge hammers. In the automobile field alone, as an example, this felt has been chosen to best serve in more than thirty purposes.

Western Felt engineers and chemists for decades have worked in close cooperation with users of felt to give them the very highest quality of material, exactness and uniformity. There are still a world of potential uses for Western Felt products, made to almost any shape, size or consistency. They range from wool softness to rock hardness. When cut, it does not fray or lose shape. It can be cut to close tolerances for such products as gaskets, washers, channels, grommets, filters, seals etc. It can be made waterproof and fungusproof and flame resistant. It will pay you to place your felt requirements in the experienced hands of Western Felt. Its counsel and products will prove profitable.

Acadia Synthetic Products Division, WESTERN FELT WORKS, Processors of Synthetic Rubbers —Sheets, Extrusions, Molded Parts.

WESTERN FELT WORKS

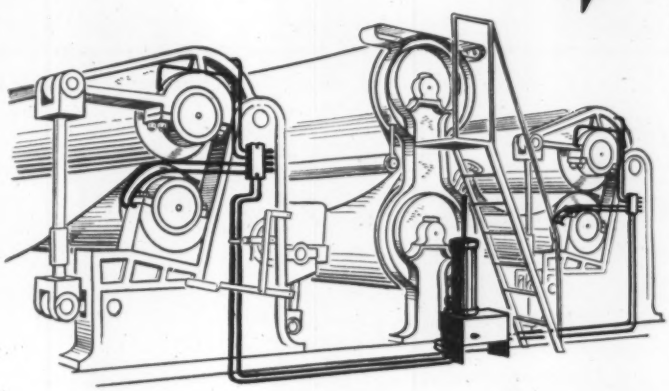
4035-4117 Ogden Avenue, Chicago 23, Illinois

Branches in All Principal Cities

LARGEST INDEPENDENT MANUFACTURERS and CUTTERS of WOOL, HAIR and JUTE FELTS

18% less h.p. load with Farval lubrication

FARVAL—*Studies in Centralized Lubrication* No. 112



IN the manufacture of paper, as the wet pulp travels through the rolls of the Kamyr press, pressures run up to 2700 pounds per inch. Lubrication by hand is usually accompanied by a noticeable power drag. Lubricant is wasted and shutdowns for bearing repair invariably follow.

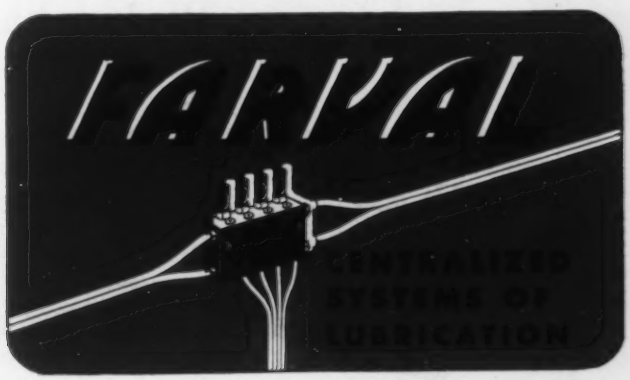
To insure continuous, uniform lubrication of its Kamyr press, a Canadian pulp mill installed Farval Centralized Lubrication. An immediate reduction of bearing friction brought a substantial reduction in power consumption. In fact, recording charts on the press show that when the Farval system was installed the horsepower load dropped as much as 18%.

On these press rolls, as on hundreds of other rolls—calendar stacks in paper mills—rubber mills—steel and brass rolling mills—Farval has proved its ability to save power, oiling labor, lubricant and bearing expense. Most important of all, it reduces downtime and increases production.

Farval has proven itself in over 20 years of service. It is the original Dualine system of centralized lubrication that others imitate. The Farval valve has only 2 moving parts—is simple, sure and foolproof, without springs, ball-checks or pinhole ports to cause trouble. Through its wide valve ports, and full hydraulic operation, Farval unfailingly delivers grease or oil to each bearing—as much as you want, exactly measured—as often as desired. Indicators at every bearing show that each valve has functioned. For a full description, write for Bulletin No. 25.

The Farval Corporation, 3265 East 80th Street, Cleveland 4, Ohio.

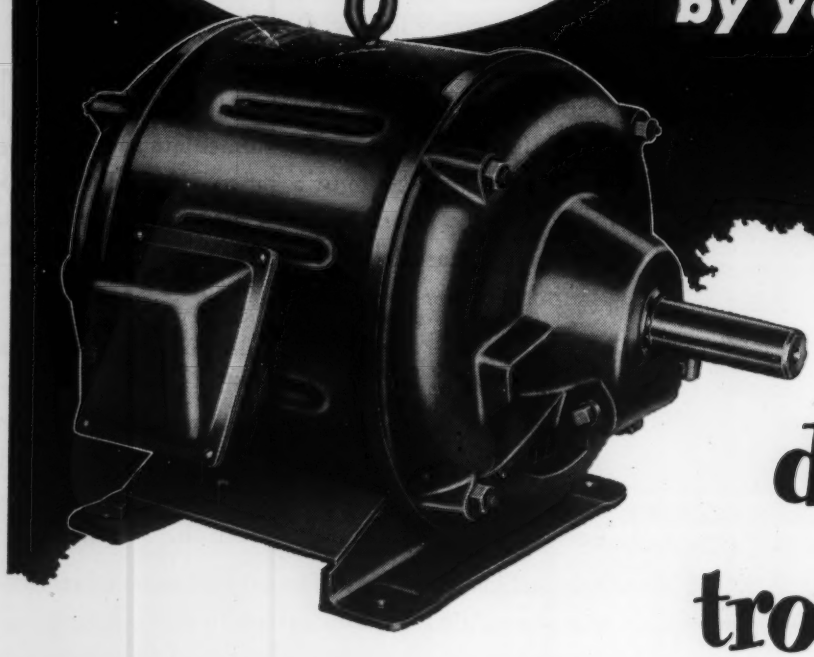
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



Wagner STEEL-FRAME Motors

Proved

by years of service!



quiet... dependable... trouble-free!

Since 1930, when Wagner started manufacturing steel-frame drip-proof motors, they have been *proved*—by years of hard usage in industry after industry.

Today this time-tested design is available in polyphase motors through 326 frame size. The motor frames are formed of heavy rolled steel, shaped to accurately center the stator core and to provide passages for adequate ventilation. An auxiliary fan draws in air through the openings in the front endplate, forces it through these passages and out through the endplate openings on the drive end. Heat is effectively carried off from all parts of the motor.

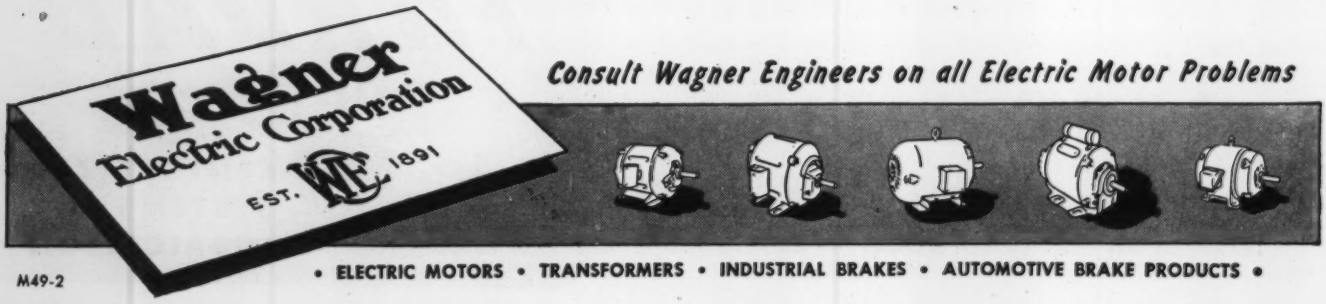
These motors are available with either sleeve or ball bearings. They are completely drip-proof when mounted in the normal horizontal position, and by rotating the endplates are still drip-proof in the sidewall or ceiling horizontal positions.

Bulletins give full information on the complete line of Wagner Motors. Twenty-nine branches, located in principal cities, are ready to assist you whenever you have a motor problem. In addition, almost 500 authorized motor repair shops provide speedy, nationwide service facilities.

Wagner Electric Corporation

6404 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems

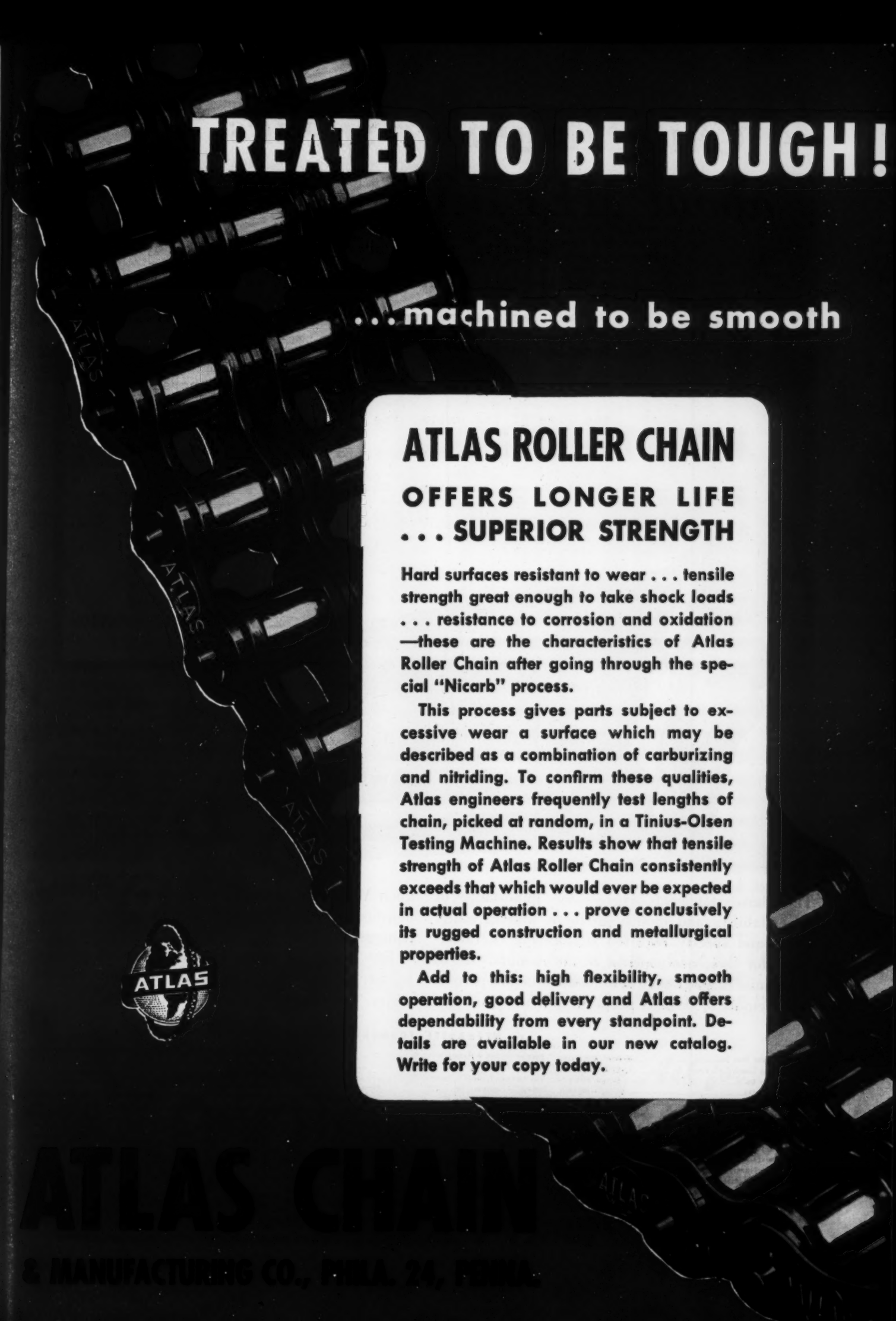


M49-2

• ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE PRODUCTS •

TREATED TO BE TOUGH!

...machined to be smooth



ATLAS ROLLER CHAIN

OFFERS LONGER LIFE ... SUPERIOR STRENGTH

Hard surfaces resistant to wear . . . tensile strength great enough to take shock loads . . . resistance to corrosion and oxidation —these are the characteristics of Atlas Roller Chain after going through the special "Nicarb" process.

This process gives parts subject to excessive wear a surface which may be described as a combination of carburizing and nitriding. To confirm these qualities, Atlas engineers frequently test lengths of chain, picked at random, in a Tinius-Olsen Testing Machine. Results show that tensile strength of Atlas Roller Chain consistently exceeds that which would ever be expected in actual operation . . . prove conclusively its rugged construction and metallurgical properties.

Add to this: high flexibility, smooth operation, good delivery and Atlas offers dependability from every standpoint. Details are available in our new catalog. Write for your copy today.

ATLAS

ATLAS CHAIN

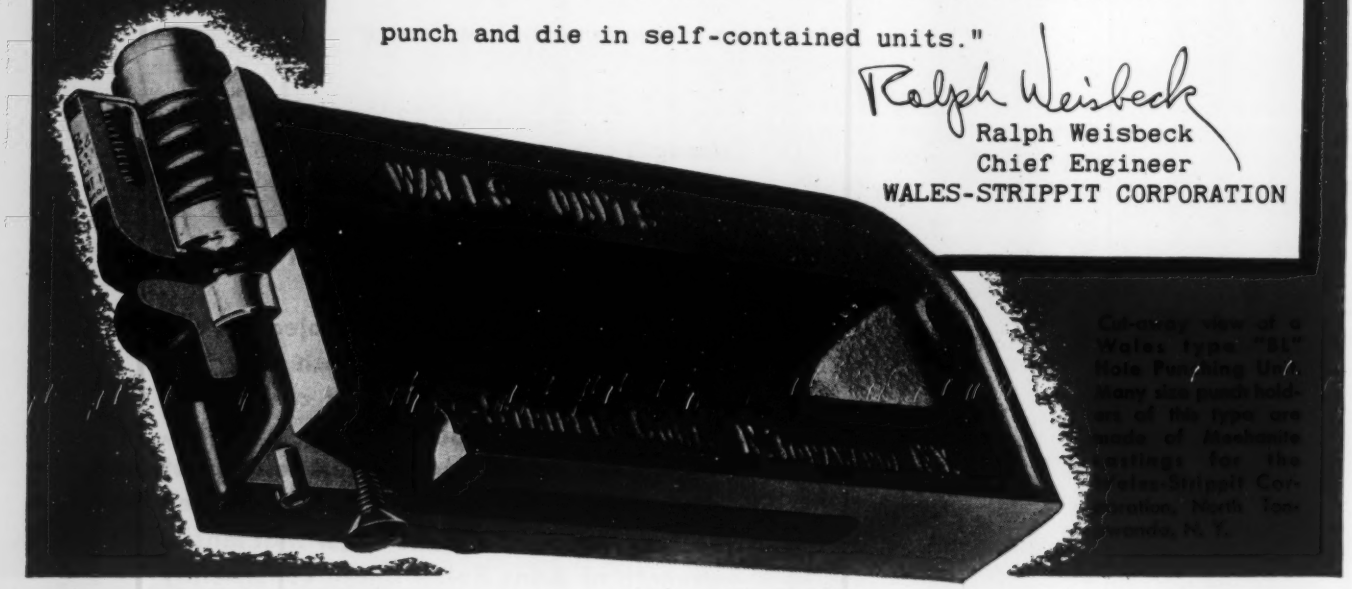
& MANUFACTURING CO., PHILA. 24, PENNA.

A Chief Engineer speaks . . . about MEEHANITE® Castings

"Meehanite castings provide the combination of qualities that definitely contributes to the successful manufacture and function of our sheetmetal perforating units. Their ability to take a smooth finish and their wear resisting properties greatly increases the life of the units. The freedom from warpage or movement after machining found in Meehanite castings is of utmost importance in maintaining alignment of punch and die in self-contained units."

Ralph Weisbeck

Ralph Weisbeck
Chief Engineer
WALES-STRIPPIT CORPORATION



The above statements express the importance of dependability and quality to those who carefully select and specify required engineering characteristics for their components. In the manufacture of Meehanite castings control of metal structure permits achievement of desired properties. When you insist upon Meehanite castings you are insuring just such benefits and economies plus built-in quality of your equipment.

For details covering a wide range of general industrial applications write for our four volume series "Meehanite Means Better Castings."

MEEHANITE FOUNDRIES

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, New Jersey
H. W. Butterworth & Sons Co.	Bethayres, Pennsylvania
Continental Gin Co.	Birmingham, Alabama
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio and Grove City, Pa.
Crawford & Doherty Foundry Co.	Portland, Oregon
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Co.	Milwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
E. Long Ltd.	Orillia, Ontario
Otis-Fensom Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Smith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
U. S. Challenge Co.	Centerville, Iowa
Valley Iron Works, Inc.	St. Paul, Minnesota
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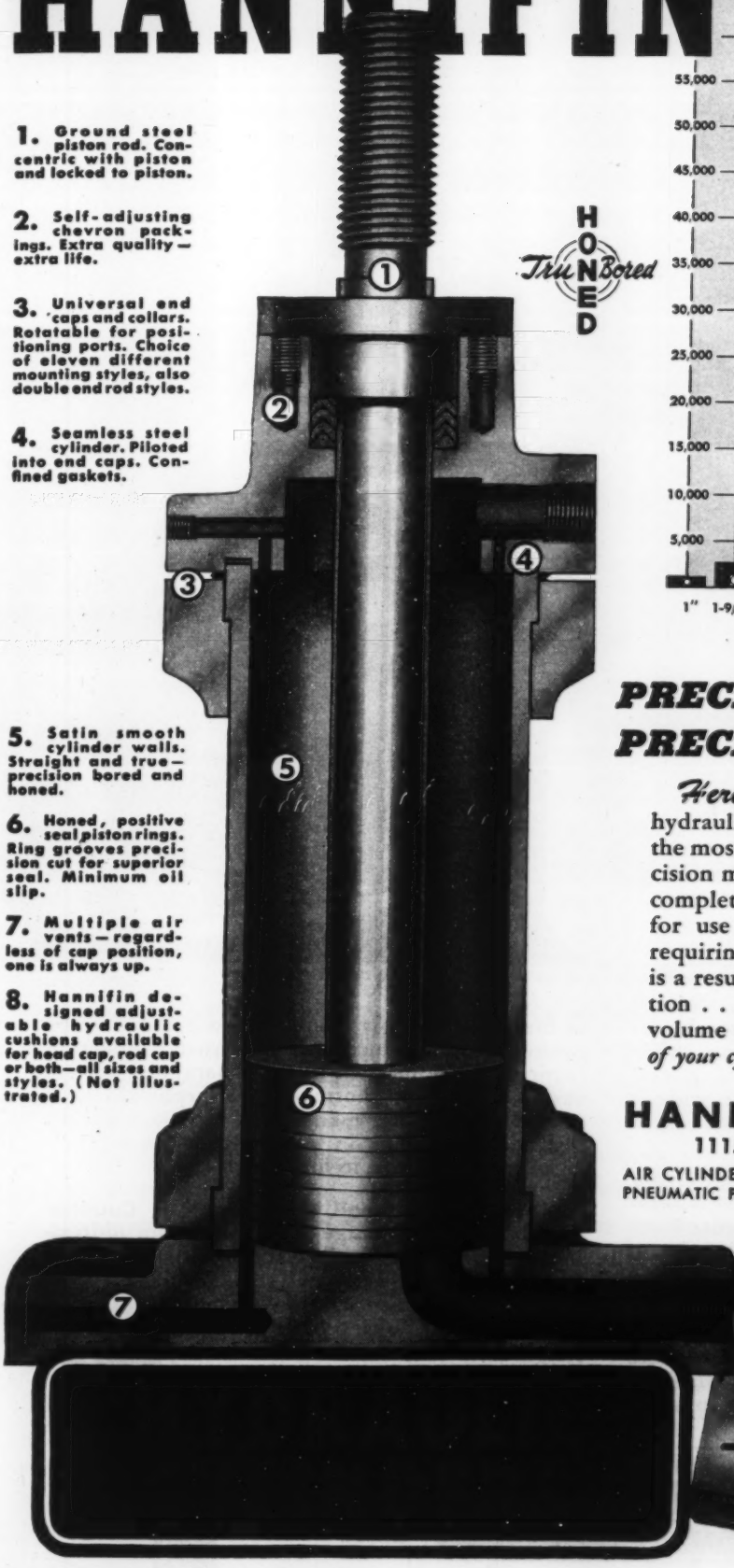
"This advertisement sponsored by foundries listed above."

[redacted] NEW ROCHELLE, N. Y.

HANNIFIN



1. Ground steel piston rod. Concentric with piston and locked to piston.

2. Self-adjusting chevron packings. Extra quality—extra life.

3. Universal end caps and collars. Rotatable for positioning ports. Choice of eleven different mounting styles, also double end rod styles.

4. Seamless steel cylinder. Piloted into end caps. Confined gaskets.

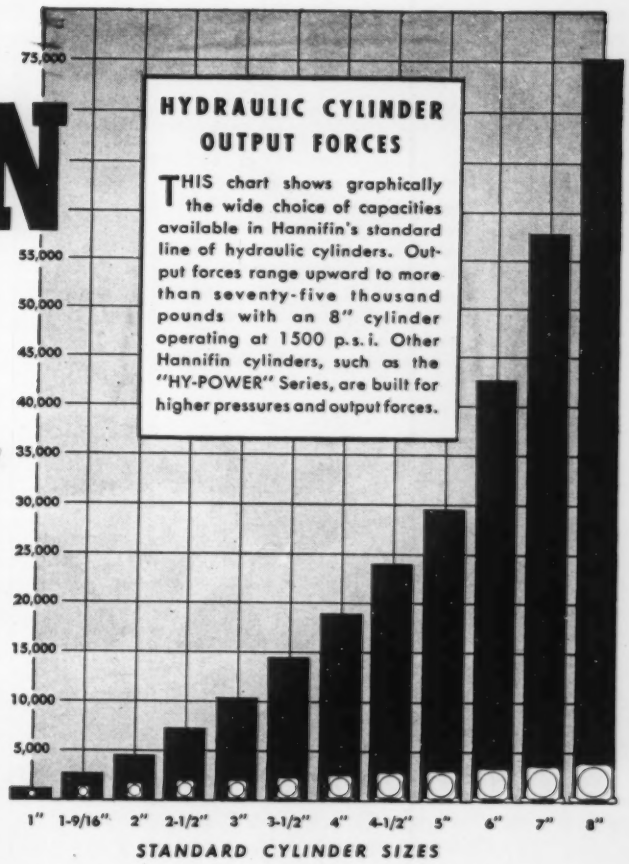
5. Satin smooth cylinder walls. Straight and true—precision bored and honed.

6. Honed, positive seal piston rings. Ring grooves precision cut for superior seal. Minimum oil slip.

7. Multiple air vents—regardless of cap position, one is always up.

8. Hannifin designed adjustable hydraulic cushions available for head cap, rod cap or both—all sizes and styles. (Not illustrated.)

HONED
True Bored



HYDRAULIC CYLINDER OUTPUT FORCES

THIS chart shows graphically the wide choice of capacities available in Hannifin's standard line of hydraulic cylinders. Output forces range upward to more than seventy-five thousand pounds with an 8" cylinder operating at 1500 p.s.i. Other Hannifin cylinders, such as the "HY-POWER" Series, are built for higher pressures and output forces.

PRECISION BUILT for PRECISION PERFORMANCE!

Here is an improved type of high pressure hydraulic cylinder that is especially built to meet the most rigid requirements of makers of finest precision machine tools. Yet it is readily available in a complete range of sizes and styles and is economical for use on even the most ordinary installations requiring the application of hydraulic power. This is a result of Hannifin's standardization of construction . . . efficiency in production . . . and large volume output. *It pays to check with Hannifin on all of your cylinder requirements!*

HANNIFIN CORPORATION
1115 So. Kilbourn Ave., Chicago 24, Ill.
AIR CYLINDERS • HYDRAULIC CYLINDERS • HYDRAULIC PRESSES
PNEUMATIC PRESSES • HYDRAULIC RIVETERS • AIR CONTROL VALVES

Ask for a copy of this **BULLETIN**

Use this 52-page bulletin as a guide for meeting all of your hydraulic cylinder requirements out of a standard line. Complete specifications and data. Ask for Bulletin 110.

"For years I've bought machines of this type... but this is the first one I ever could

COUNT ON!"

Give your customers (and customers-you-hope) the thrill of discovery . . . of discovering something *new* in your product . . . something that gives them *new* advantages in use . . . *new* pride of ownership . . . *renewed* respect for you as a modern merchandiser!

How? Build a Veeder-Root Counter into your product. *But what kind of counter, and how to build it in?* Those are questions that a Veeder-Root engineer will answer promptly and squarely . . . if you let him concentrate his "mathematical eye" on your product.

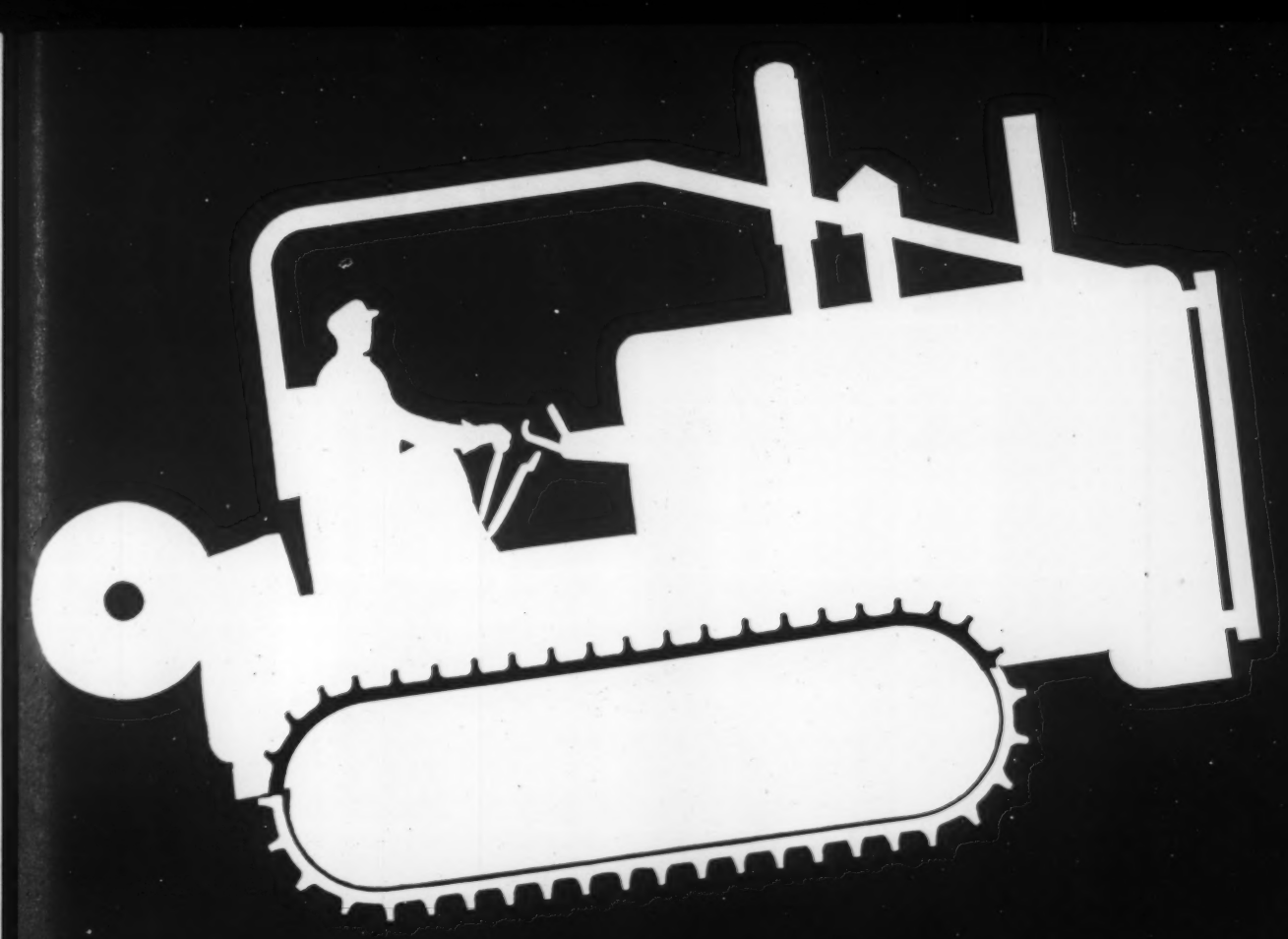
And why let him do that? Because there are so many types of Veeder-Root Mechanical and Electrical Counters . . . and because so many of the most successful applications were not apparent at first, *at all.* Now, couldn't you *profit more* by having your product keep its own production records, prove its own service guarantee, protect customers against shortages and surpluses . . . or provide any of the many other new advantages that come with built-in Veeder-Root *Count*rol? It costs exactly 3 cents to find out. *Write.*

No. 1122 V-R Small Reset Ratchet Counter is built into a wide range of products from addressing machines and aerial cameras to hay balers, laundry machines, linotypes, shoe machinery, machine tools and — what have *you?* For a quick picture of the range of V-R Counters, send for free 8-page Condensed Catalog (shown). *Write now.*

Veeder-Root COUNTERS

VEEDER-ROOT INC., HARTFORD 2, CONNECTICUT

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.



IN ACTION WITH THE HEAVYWEIGHT CHAMPS

To meet the needs of construction men and loggers, tractor manufacturers keep building bigger and bigger models. The largest tractors on the market today . . . giants that put plenty of wear and tear on brakes and clutches . . . use R/M friction materials as original equipment.

That's another example of R/M leadership in developing new friction materials to meet new industrial requirements. Through the years, R/M has led not only in developing new *sizes* of friction materials (from the largest to the smallest available) . . . but also in new formulas (dry process, semi-metallic, and flexible pulp, to name a few) . . . and in new *installation methods* (bonding, for example).

Whatever your problem in brakes or clutches, call in your R/M representative. He'll welcome the chance to help you. And he'll call, when needed, on the experience of four great plants, four research organizations, and four testing laboratories . . . assets that become yours when you deal with the world's largest producer of friction materials.

RAYBESTOS-MANHATTAN, INC.

EQUIPMENT SALES DIVISION **620 Fisher Bldg., Detroit 2, Mich.**

445 Lake Shore Drive, Chicago 11, Ill. 4651 Pacific Blvd., Los Angeles 11, Calif.

1071 Union Commerce Bldg., Cleveland 14, Ohio

Factories: Bridgeport, Conn. Manheim, Pa. Passaic, N.J. No. Charleston, S.C.

RAYBESTOS-MANHATTAN, INC., Manufacturers of Brake Linings • Brake Blocks • Clutch Facings Fan Belts • Radiator Hose • Mechanical Rubber Products • Rubber Covered Equipment • Packings Asbestos Textiles • Powdered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

FIRST IN FRICTION

You Can Avoid Motor Burnouts

...by using motors with

KLIXON

MOTOR PROTECTORS

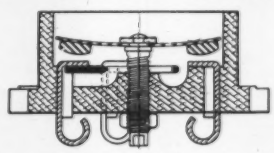
There is *no* need to put up with motor burnouts in your equipment especially when *you can prevent* this major headache simply and at surprisingly low cost.

Here's all you need do . . . when you buy motors *specify that they have built-in Klixon Motor Protectors.*

These simple, foolproof protectors take into account the factors that cause motors to overheat and burn out and shut the power "off" should they become dangerously overheated. Then when they cool to a safe operating temperature, they snap the power "on" again automatically or by pushing the reset button, depending on the type of protector used.

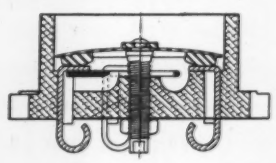
Klixon Protectors are unaffected by vibration, motion or shock. Harmless overloads of short duration do not cause nuisance tripouts. Protect your motors and other electrical equipment, such as transformers, solenoids, adjustable transformers, from burning out . . . specify equipment with built-in Klixon Protectors.

HERE'S HOW THEY OPERATE



CLICK...IT'S OFF!

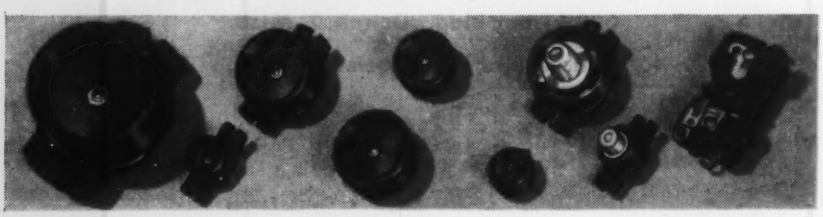
When temperature within the equipment reaches the danger point, the Klixon Protector snaps the power "off" preventing burnouts.



CLICK...IT'S ON!

When the equipment cools to safety, the Klixon Protector snaps the power "on" automatically when the automatic reset type is used . . . or by pushing the reset button when manual reset type is used!

Illustrated below are a number of typical Klixon Protectors



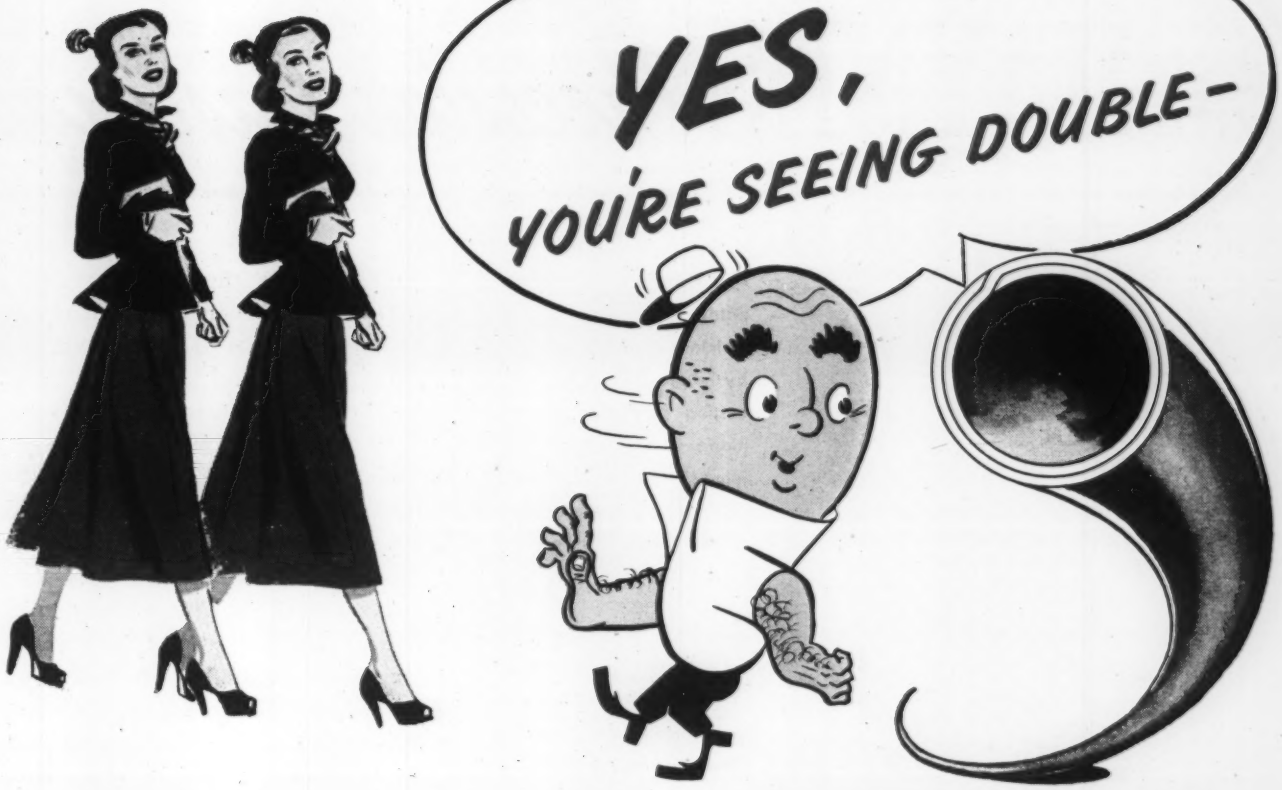
KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corp.

2509 FOREST STREET, ATTLEBORO, MASS.

Wichita City Library



—and it's a good sight for your eyes, too!

For you're looking at *double-walled* Bundyweld* Tubing! In steel, Monel or nickel, it's a *double*-duty, *doubly* strong, *doubly* useful tubing well worth a long second glance.

Bundyweld's patented construction doubles up with the special features of nickel and Monel to offer *advantages that no other tubing can match.* It's ductile, lightweight, faster-cooling—a real miracle tubing of industry.

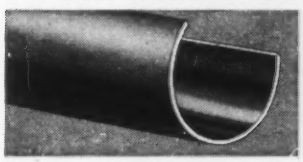
Perhaps you have a new idea where an application of extra-strong, sturdy Bundyweld may help out. We *used* to think there weren't any left. But designers keep on specifying it, and uses seemingly double daily.

"Oh, yeah!" you say?

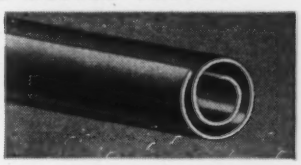
Well, maybe not *that* fast, but here are a few instances to show you what we mean. Take weather-resistant, non-sagging Bundyweld for television antennas. Or leakproof Bundyweld for radiant heating. Again, ink cartridges for ball-point pens, ledger posts in accounting books—the list is as long as it is amazing.

What about *your* new idea? Like some help on it? Or more information on Bundyweld? Just contact one of the representatives below, or write: *Bundy Tubing Company, Detroit 14, Michigan.*

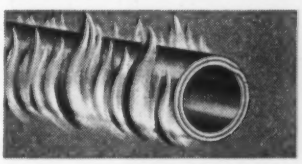
WHY BUNDYWELD IS BETTER TUBING



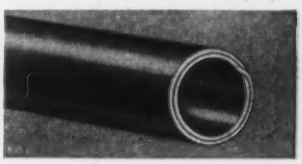
1 Bundyweld Tubing, made by a patented process, is entirely different from any other tubing. It starts as a single strip of basic metal, coated with a bonding metal.



2 This strip is continuously rolled twice laterally into tubular form. Walls of uniform thickness and concentricity are assured by close-tolerance, cold-rolled strip.



3 Next, a heating process fuses bonding metal to basic metal. Cooled, the double walls have become a strong ductile tube, free from scale, held to close dimensions.



4 Bundyweld comes in standard sizes, up to ⅝" O.D., in steel (copper or tin coated), Monel or nickel. For tubing of other sizes or metals, call or write Bundy.

BUNDY TUBING

★ ★ ★ ★

ENGINEERED TO YOUR EXPECTATION!

*REG. U. S. PAT. OFF. ®

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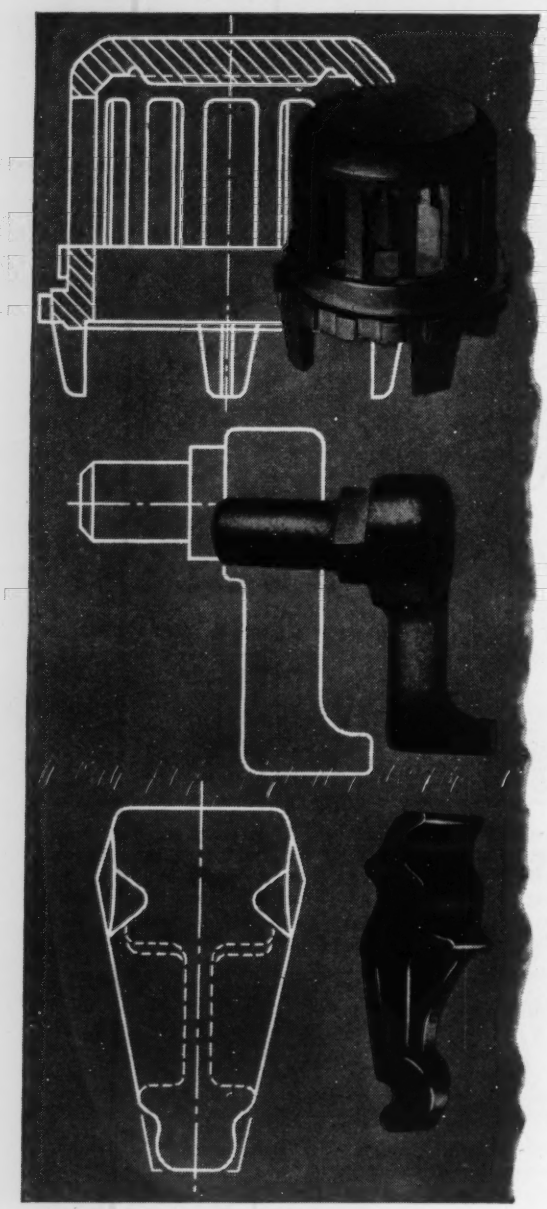
BUNDYWELD NICKEL AND MONEL TUBING IS SOLD BY DISTRIBUTORS OF NICKEL AND NICKEL ALLOYS IN PRINCIPAL CITIES.

Intricate Shapes at Reasonable Cost with HAYNES Trade-Mark *Precision Castings*



Assembly costs are eliminated by producing this stainless steel valve cage by the precision investment-casting process. Formerly made in two pieces and joined together, the cage is now produced as a single, integral casting.

This screw cycle controller is investment-cast from a one-piece wax pattern. The part was formerly made by brazing together two individual pieces machined from bar stock.

This HAYNES STELLITE alloy sealing segment was redesigned in order to avoid warpage and distortion. Although the ribbed section—which was formerly solid—adds to the intricacy of the part, it causes no fabrication difficulties when produced by HAYNES precision investment casting.

The alloys that are available as HAYNES precision investment castings—such as HAYNES STELLITE, HASTELLOY, and MULTIMET alloys, and certain stainless steels—are strong materials that resist the most severe abrasion, heat, and corrosion. But because of their unusual properties, these alloys are often difficult and costly to fabricate by conventional methods. The precision investment-casting process, however, is a practical method of producing parts from these materials. And it makes possible the liberal use of such design features as thin edges, fillets, irregular holes, and intricate contours.

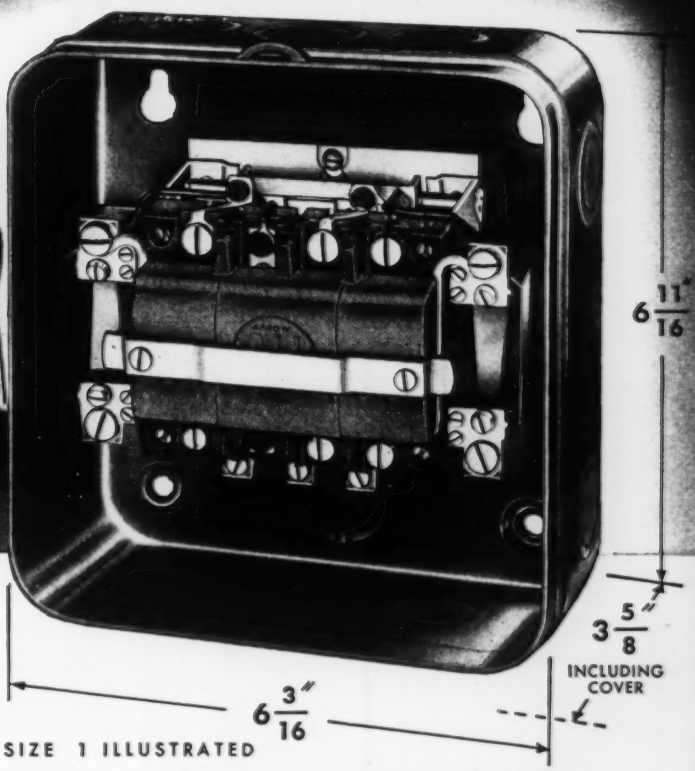
If you need production quantities of an intricate part cast to close tolerances, investigate HAYNES precision investment castings. You will find that they are smooth and uniform—and held to such close dimensional standards that several finishing operations might be eliminated. Our engineers will co-operate with you in designing new parts to be precision investment-cast, or in re-designing parts for greater efficiency and increased economy. For more information, write for the booklet "HAYNES Precision Castings."

HAYNES TRADE-MARK *alloys*

Haynes Stellite Company
Unit of Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago—Cleveland—Detroit—Houston
Los Angeles—New York—San Francisco—Tulsa

The trade-marks "Haynes," "Haynes Stellite," "Hastelloy," and "Multimet" distinguish products of Haynes Stellite Company.

EASY to Service



SIZE 1 ILLUSTRATED

ARROW AH HART

NEW "RA" SIZE 1 MAGNETIC STARTER

THE SMALLEST STARTER ON THE MARKET

AVAILABLE IN LOCAL AND REMOTE CONTROL OR SELECTOR SWITCH TYPES

Working electricians — installation and maintenance men — have approved the new Arrow-Hart "RA" Magnetic Starter. Its new design makes wiring easier — straight through all the way — provides roomier wiring space in smaller enclosures and requires less mounting space when installed on panels.

Servicing is easy, too. All terminals and contacts are reached quickly with no waste time or motion. And it is *easier* to install in *smaller* spaces without sacrifice of accessibility or convenience. There's a lot of performance packed into the small and compact enclosure — 6-3/16" x 6-11/16" x 3-5/8". Because of its space-saving features, it outdistances conventional starters in design and performance.

Put these features together and you have the new Arrow-Hart "RA" 1 Magnetic Starter. You get quick, easy hook-ups, long unit life and low maintenance cost. You get a starter that's compact, sturdy and dependable mechanically and electrically — one you can rely on for outstanding performance.

NEW TYPE "RA" AVAILABLE IN SIZES 0, 1, 2 AND 3

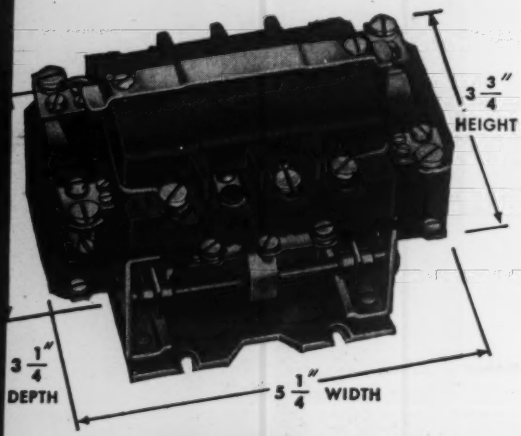
CONTROLS and APPARATUS FOR *Outstanding* PERFORMANCE

ARROW AH HART

ARROW-HART

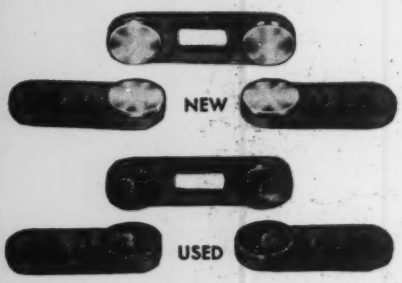
ARROW-HART NEW "RA" MAGNETIC STARTERS ARE EASY TO WIRE - - EASY TO SERVICE

Here's Why



Simplicity of design speeds up installation and maintenance time; saves you money by shortening shutdowns. Be convinced. Loosen one screw — the enclosure cover lifts off and is free of dangling wires. Terminals are all top exposed for direct wiring. Contact inspection or replacement is made readily by loosening two hood retaining screws. Switch can be quickly removed from enclosure by loosening three mounting screws.

BIG, TOUGH CONTACTS



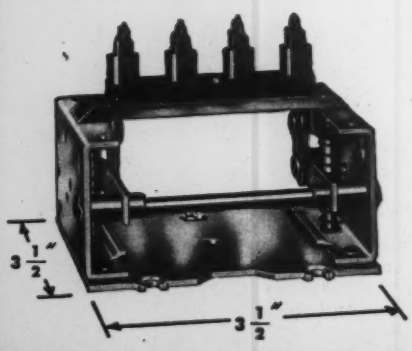
Here are rugged, heavy duty, copper contacts with special silver alloy tips that will take plenty of punishment. Special hidden spring-loaded keys provide speedy and easy change of contacts. Simply lift contact to clear guide post — permitting 90° turn of key to free contact. Replace contact and spin key into locking slot. No loose parts.

Contact surfaces after several hundred thousand cycles at 50 Ampere, 440 Volt, 50% power factor on motor load.

PLASKON ALKYD PROTECTION

New thermosetting molding compound used in A-H base and hood features phenomenally high resistance to tracking. ASTM standard test procedure proves that Plaskon Alkyd exceeds the arc resistance of the next best material by 50% to 65%. Does not support combustion. Provides hard and durable surface and superior dimensional stability. The introduction of Plaskon Alkyd is another step to insure maximum performance and long life in Arrow-Hart "RA" Magnetic Starters.

HERE'S BALANCED MECHANISM



Right angle balanced mechanism multiplies the leverage and transfers it from a vertical to a horizontal plane. Correct contact pressure is assured at all times with reduced wattage consumption of the magnet coil.

Arrow-Hart Magnetic Starters are available in sizes 0, 1, 2 and 3, to handle motors up to 50 H. P. at 440 and 550 Volt. Write for folder giving wiring diagrams, catalog data and other information.

Buy with Confidence
Profit by Performance

ARROW AH HART

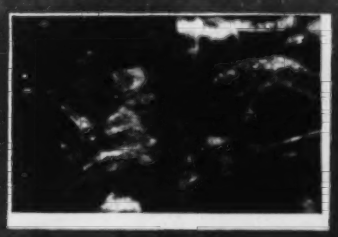
NATIONAL OIL SEAL LOGBOOK

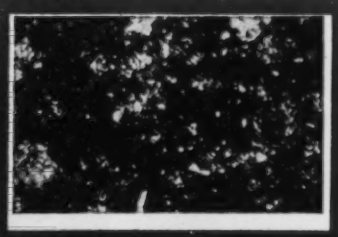
LEATHER vs. RUBBER OIL SEALS

Which is better? And when?

There has been much controversy during the past ten years on the relative merits of leather vs. synthetic rubber for use in oil seals. In considering this subject, it should be remembered that performance of leather oil seals is limited to the inherent capabilities of the leather itself as a raw material, even granting improvements gained through various impregnation tanning and finishing processes. Synthetic rubber, on the other hand, can be especially compounded for the job, and is immune to many industrial chemicals which would deteriorate leather. Nevertheless, there is a place for both materials in the picture.

PHOTOMICROGRAPHS SHOW INHERENT DIFFERENCES





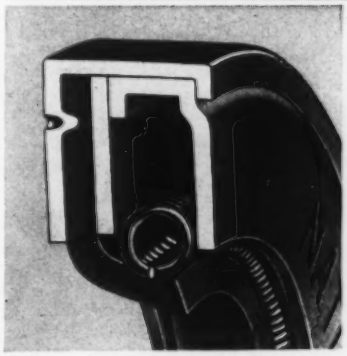
Given fine tolerance designing, expert manufacture and mirror-bright shaft finishes, either rubber or leather oil seals will perform well; but when machinery must be designed to broad tolerances and finishing is relatively rough, leather seals are generally more practical. Because leather sealing members are more resistant to abuse, they are recommended when service conditions are inexpert, particularly where lubrication is apt to be neglected. When utilizing leather seals, the designer should consider the relatively greater torque.

Fundamentally, synthetic rubber oil seals are more resilient, withstand higher temperatures and create considerably less drag, while forming a near-perfect closure around moving shafts. Where torque is a factor and high speeds are encountered—where run-out, shaft whip or eccentricity are extreme—where the machine is unusual or intricate—rubber seals are ideal.

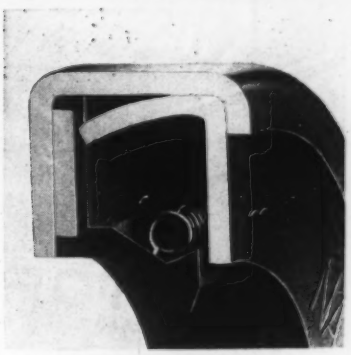
In National Oil Seals, leather sealing members have been "Nationalized", a process which helps leather retain precise shape and size and also withstand heat. National synthetic rubber oil seals employ "Syntech*", which is specially compounded for use in seals.

National engineers are at your service to help you solve any oil sealing problem. For further information please contact nearest office.

In some applications it is good practice to use both leather and rubber oil seals—either separately or in combination—such as shown in the dual wipe seal at left.



National spring-loaded leather seal



National spring-loaded Syntech* rubber seal

NATIONAL
OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, Calif.
Plants: Redwood City and Los Angeles, Calif.; Van Wert, Ohio

Syntech is the registered trademark for the National synthetic rubber compound.

1363

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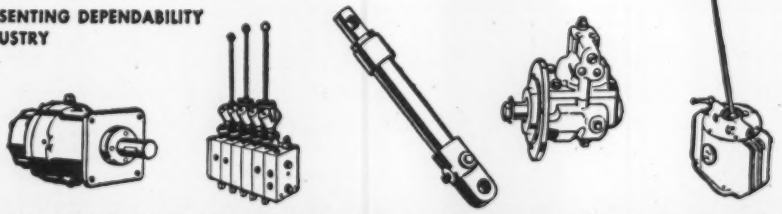

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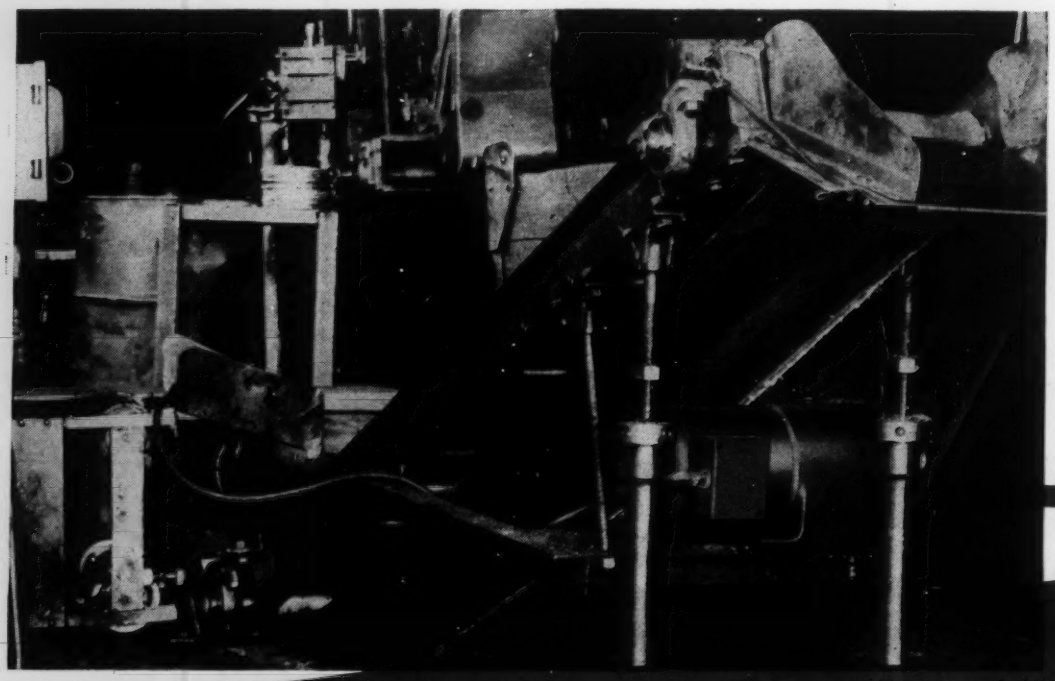


Century ¼ horsepower squirrel cage, gear motor driving a conveyor.

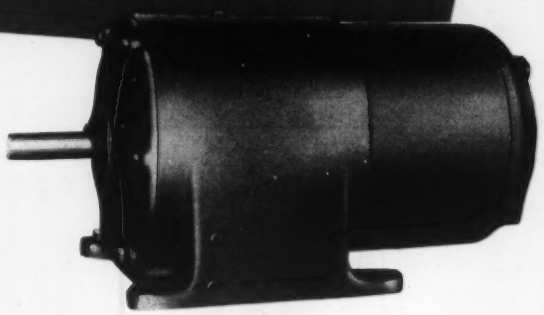
Match the Speed and Power Requirements of Your Conveyors With Century GEAR MOTORS

The conveyor shown here is driven by a Century Gear Motor which provides the correct power and speed to handle the output of a punch press.

Century Gear Motors are available in sizes from 1/6 to 1½ horsepower to provide many combinations of power and speed. The right combination on your materials handling equipment will help to coordinate your production, reduce handling costs and increase efficiency.

Century Gear Motors are engineered to maintain the high torque slow speed shaft in rigid alignment. Mounting feet are an integral part of the rugged, compact gear housing—providing a strong rigid unit.

Specify Century Gear Motors for all your slow speed requirements.



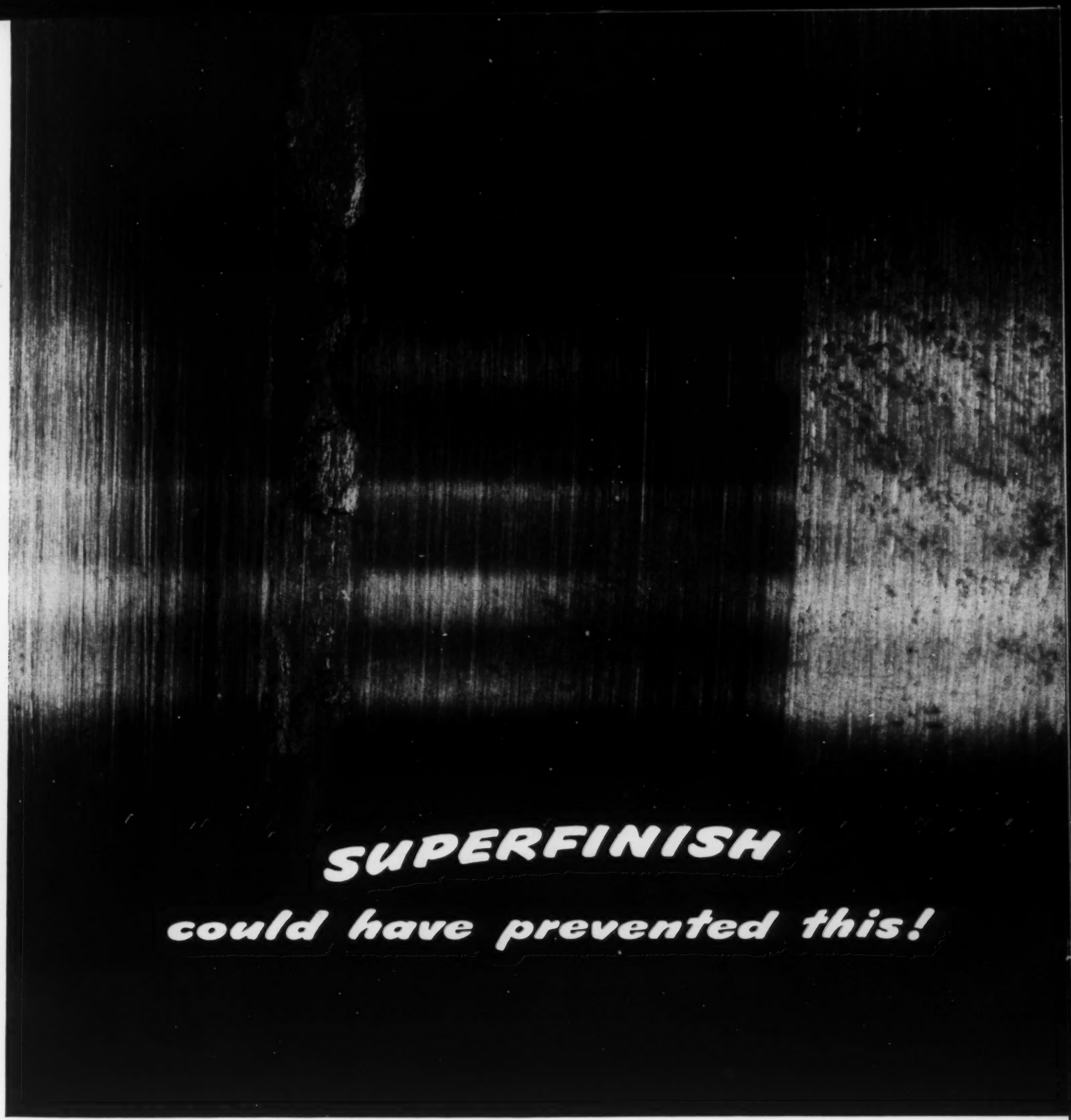
Popular types and standard ratings are generally available from factory and branch office stocks.

Century C MOTORS

-637

CENTURY ELECTRIC CO. 1806 Pine Street • St. Louis 3, Missouri

Offices and Stock Points in Principal Cities



Enlargement shows a scored and galled surface of a 3½" O.D. bearing that "froze" and failed. Had this surface first been Superfinished, it would have had nearly twice the load-bearing capacity and about three times the life. "Wear and Surface Finish," is a new textbook on Superfinish. Write for it on your company letterhead.

GISHOLT MACHINE COMPANY
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THE GISHOLT ROUND TABLE

represents the collective experience of specialists in machining, surface-finishing and balancing of round and partly round parts. Your problems are welcomed here.

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INSUROK has become a symbol of quality wherever plastics are used, and Richardson laboratory, engineering and production skills have written important chapters in the development of many products, both for military and peace-time use.

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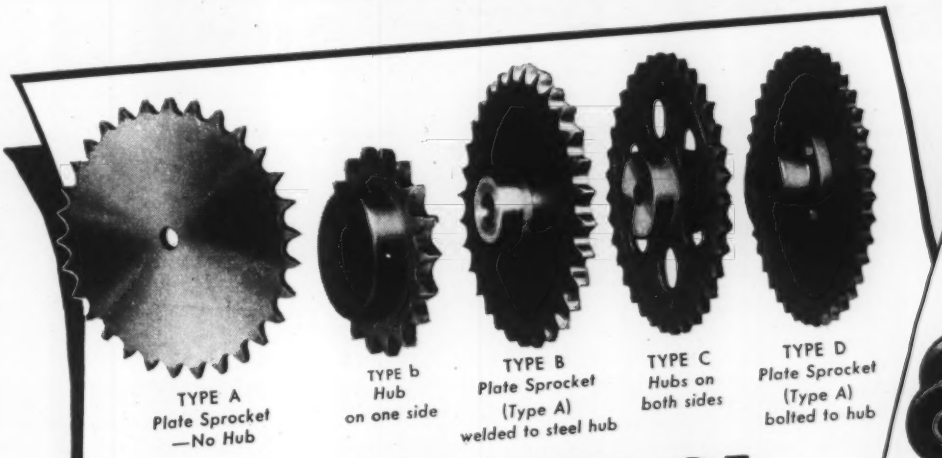


TYPE A
Plate Sprocket
—No Hub

TYPE b
Hub
on one side

TYPE B
Plate Sprocket
(Type A)
welded to steel hub

TYPE C
Hubs on
both sides

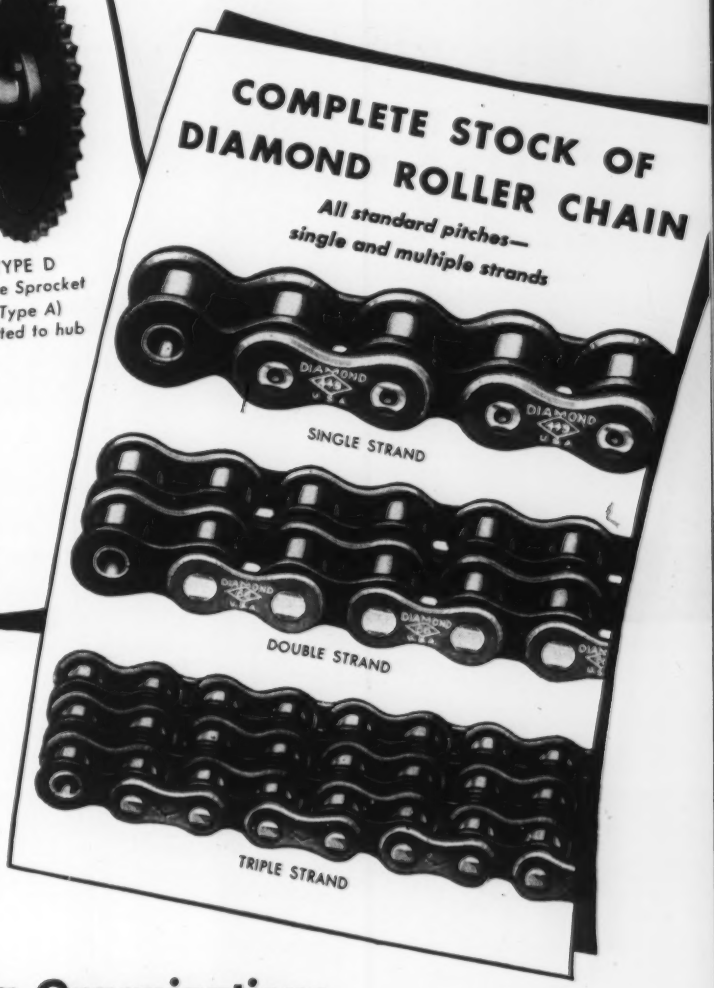
TYPE D
Plate Sprocket
(Type A)
bolted to hub

A LARGER LINE OF DIAMOND STOCK SPROCKETS

For single and multiple strand chains

COMPLETE STOCK OF DIAMOND ROLLER CHAIN

All standard pitches—
single and multiple strands



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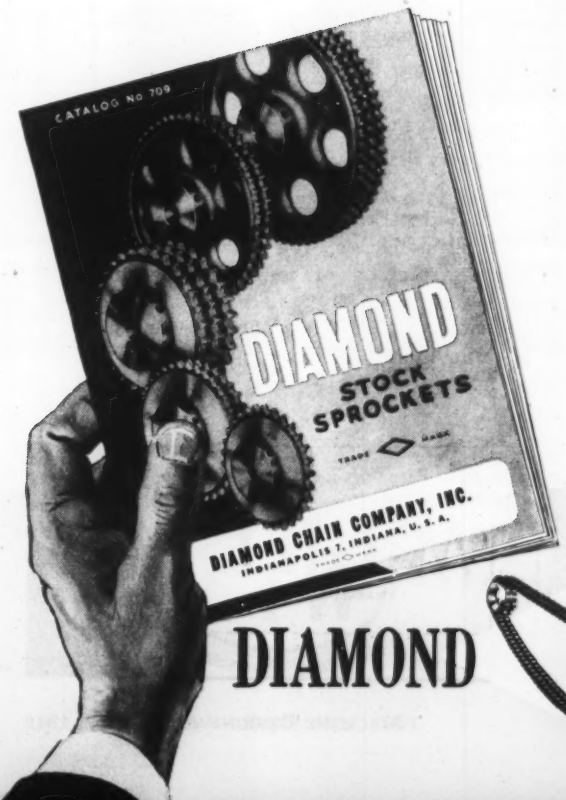

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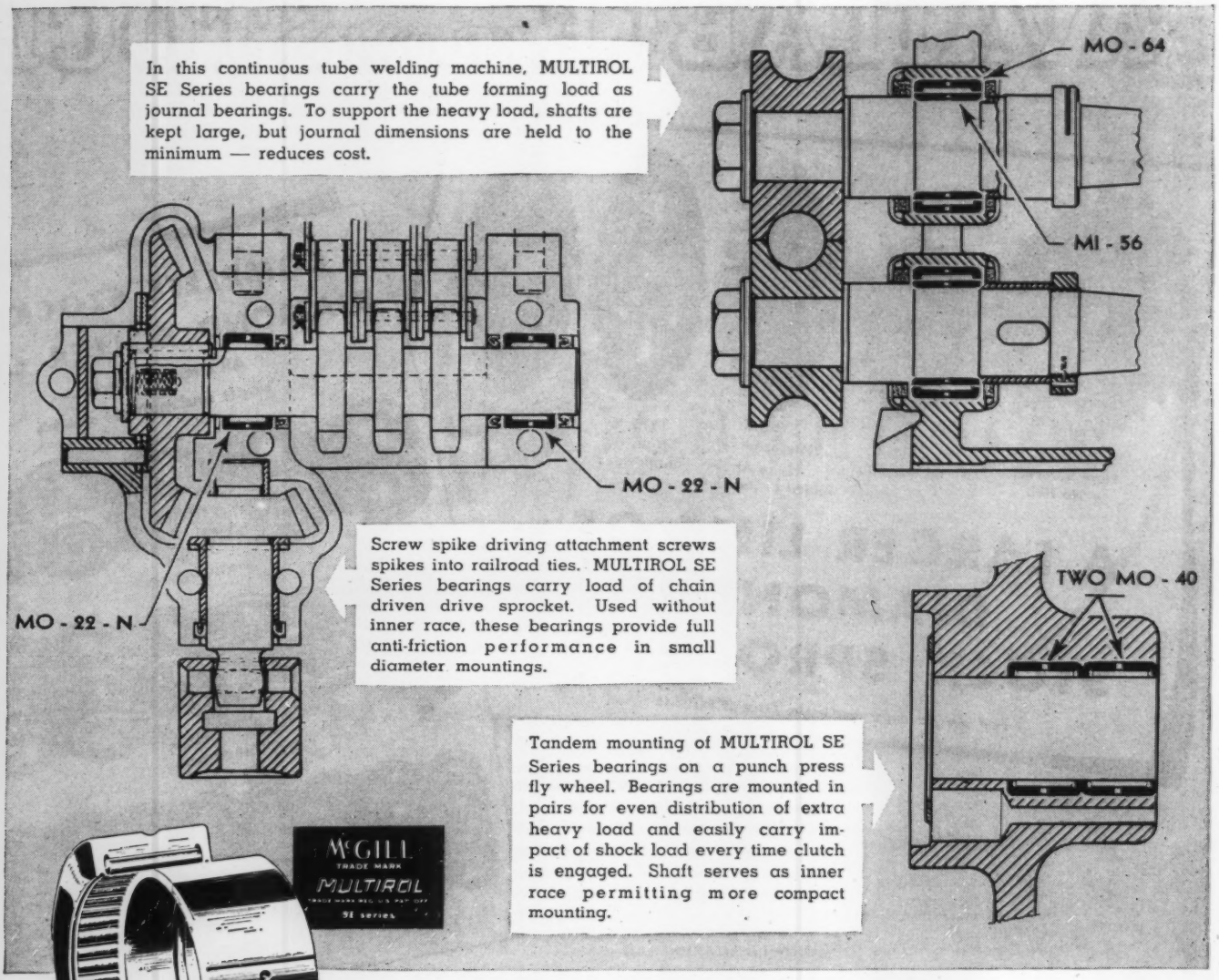

how to anti-frictionize for improved performance

THE MULTIROL WAY

The efficiency of any machine can be raised when plain friction bushings are replaced with MULTIROL SE Series full type roller bearings. Speeds are easily increased and accuracy improved over a longer expected bearing life.

The MULTIROL Way requires less maintenance because lubrication can be provided through either the shaft or housing — oil holes and channels in both outer and inner — no need for constant oiling — no danger of dry journals when lubrication is temporarily neglected.

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MULTIROL SE Series bearings are anti-frictionizing machines in all industries. The above drawings illustrate typical examples of improved bearing applications. We will gladly make engineering recommendations for you. Write today for helpful MULTIROL Bearing literature.

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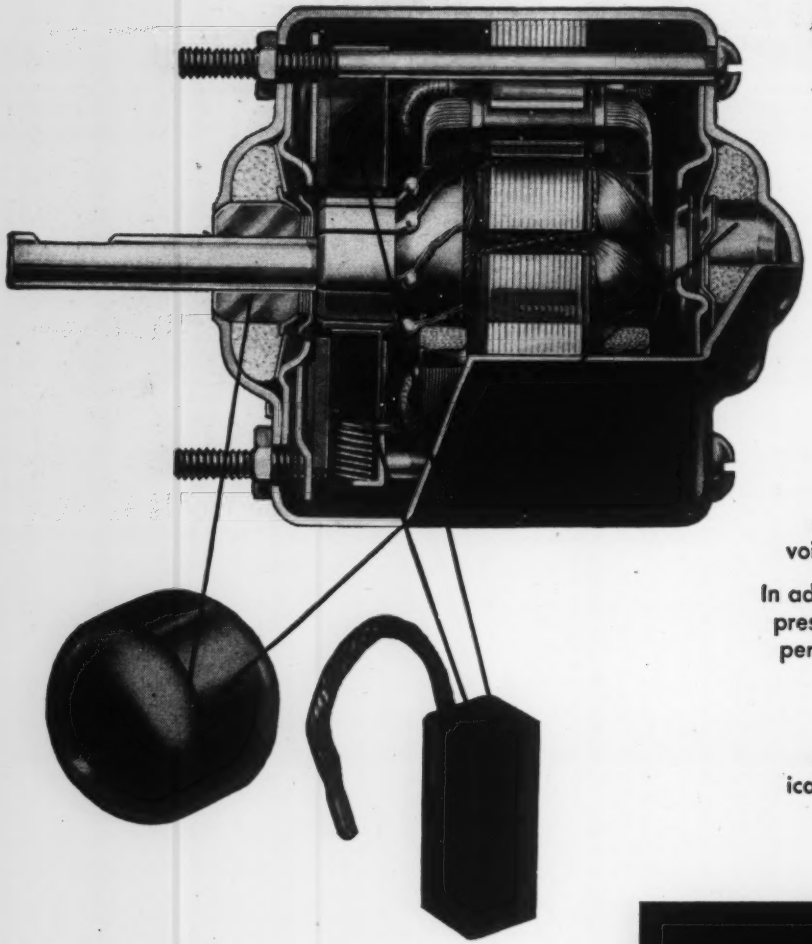
precision bearings

Continental holders and cutters are available individually or in standard tool room sets. Send for Catalog No. D27161.

49-29

CONTINENTAL TOOL WORKS
DIVISION OF EX-CELL-O CORPORATION
DETROIT 32, MICHIGAN

gramix bearings and U.S.G. brushes help insure efficiency of *Redmond* Micromotors



Gramix powder metal bearings and U. S. G. brushes are two important reasons for the outstanding dependability of Redmond Micromotors. U.S.G. copper-graphite brushes have high current carrying capacities and provide positive, noiseless commutator contact. The Gramix bearings reduce shaft play and noise, because they are self-aligning and are selectively fitted to the shaft to retain clearance within .0005". They provide automatic lubrication, with microscopic pores that filter lubricant from the reservoir and distribute it evenly and freely.

In addition, Gramix bearings cost less. They are die-pressed from powdered metal to exact size and with perfect bearing and sliding surfaces, eliminating costly machining. Send us sketches or descriptions of your products, and we will show you where Gramix bearings, washers, gears, and other powder metal parts will improve mechanical performance and save you money. WRITE TODAY FOR NEW GRAMIX CATALOG.

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We manufacture a complete line of brushes for all types of rotating electrical equipment. Types include carbon-graphite, pure graphite, and metal-graphite with electrical carrying capacity ranging from 30 to 150 amperes per square inch. Our engineers will be glad to assist you in determining which grade and type of USG brush is best suited to your requirements.

gramix bearings
U.S.G. brushes

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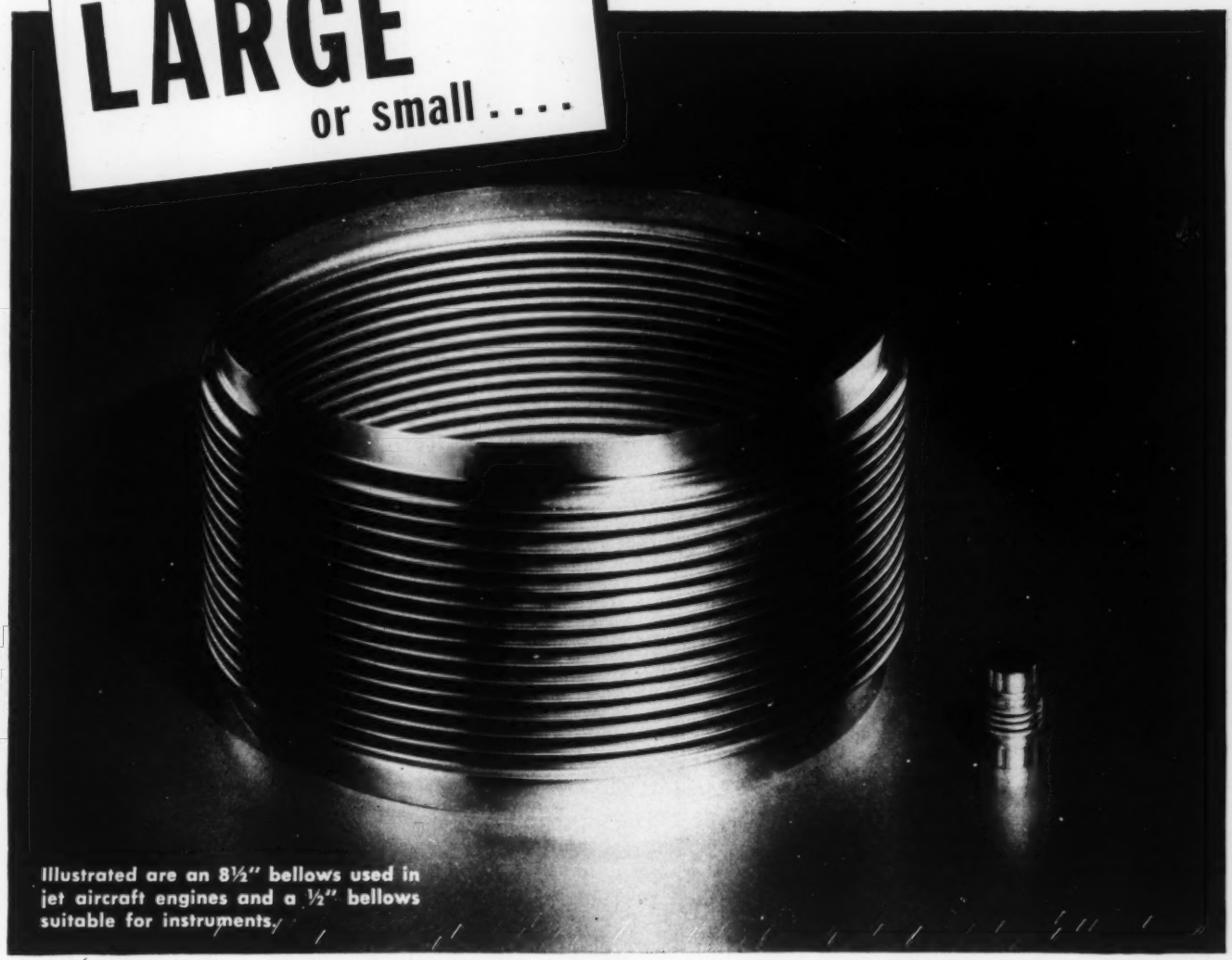
DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

LARGE or small....



Illustrated are an 8½" bellows used in jet aircraft engines and a ½" bellows suitable for instruments.

There is a CMH Bellows to meet every requirement

Although CMH manufactures bellows of greater diameter than the larger of the two illustrated above, this photograph conveys the wide size range in which CMH Bellows are available. Whatever the size—1/2" and up—CMH Bellows are precision made to meet the most exacting requirements. Advanced manufacturing methods permit the forming of most types as standard production items with the obvious advantages of greater uniformity and lower cost.

Whatever your bellows needs, inquire about CMH Stainless Steel and Brass Bellows. Write for complete information.

CMH—ONE dependable source for every flexible metal hose requirement

• CMH manufactures all standard types of flexible metal hose, both convoluted and corrugated, in a variety of metals; expansion joints for piping systems; stainless steel and brass bellows; various conduits and special assemblies of these components.

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FOR ENGINES OF
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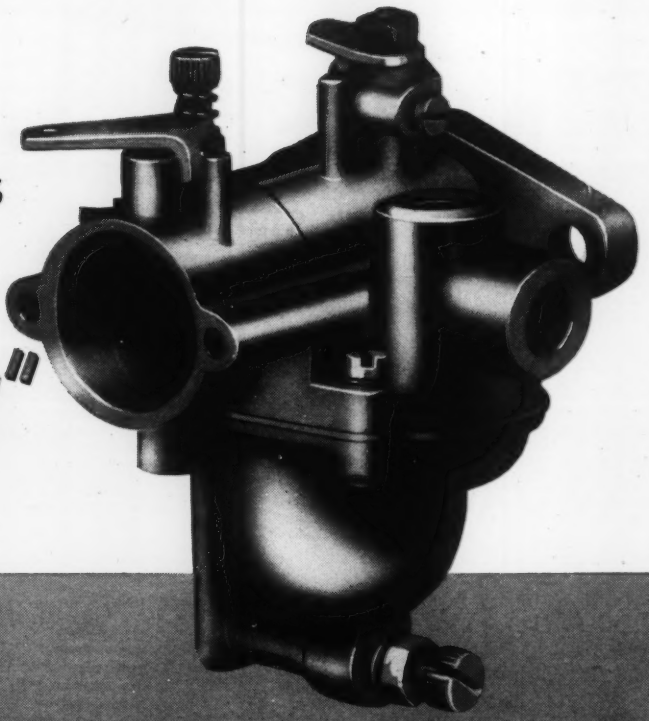
THE NEW ZENITH

"WORKHORSE"



A Thoroughbred

THROUGH and THROUGH.....Because it's Built by

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40 years' experience in specialized carburetion

- High angularity design
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- Reasonably priced
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- May be balanced so the air cleaner has a minimum influence on fuel-air ratio

Strict adherence to the highest standards of quality and performance through 40 years of experience have made Zenith* the undisputed leader in the field of heavy-duty carburetion. Now, Zenith has incorporated these same characteristics into the "Workhorse", a compact, lightweight carburetor ideally suited for engines of 5 horsepower or less. Its high angularity design assures dependable operation even when severely slanted. Simplicity of installation, easy maintenance and reliable performance make it a real "Workhorse". And because it is made by Zenith, you know it is a thoroughbred through and through.

*REG. U. S. PAT. OFF.

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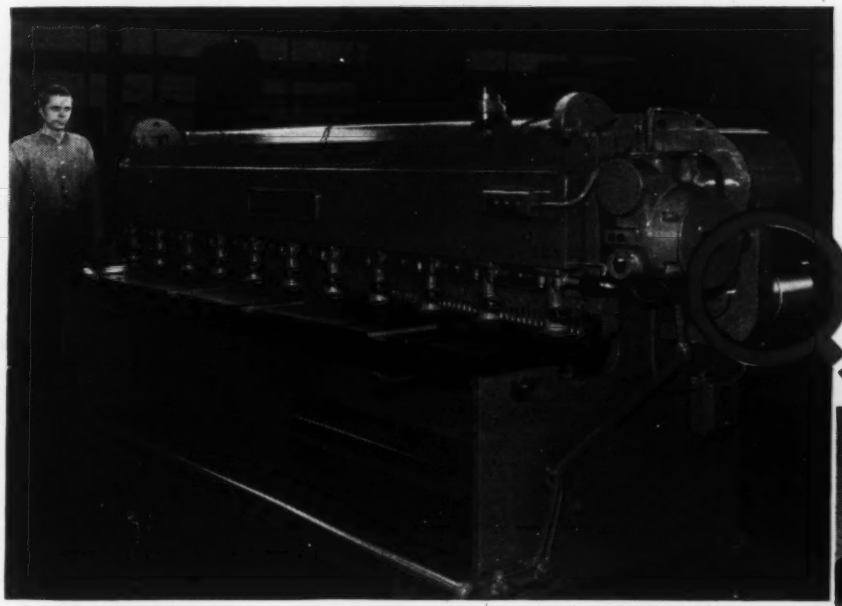
A.O. Smith Builds ELECTRIC MOTORS

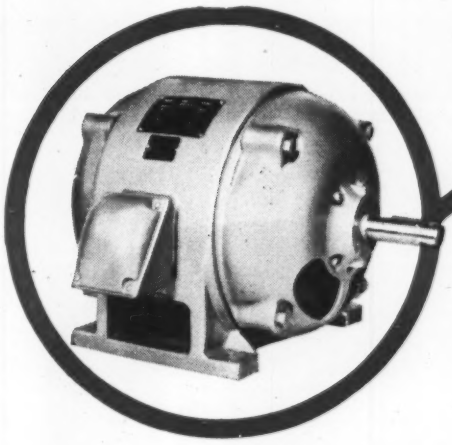


for hundreds of products, including CINCINNATI SHEARS

Ask the A.O. Smith man about electric motors for both special and standard uses

To help you integrate motor design with product design—to achieve the most efficient and most economical operation—the research and engineering staff at A. O. Smith is at your disposal. If you seek improved performance in your product, if you require special characteristics in your power component, in custom-built or in standard electric motors, consult the A. O. Smith man. Typical of his service is the machine tool, illustrated here, of The Cincinnati Shaper Co.

WRITE FOR A.O. SMITH BULLETIN No. EM-152



CINCINNATI ALL-STEEL SHEAR

Cuts sheet metal to micrometer-measure tolerances, and shears with this accuracy at high speed. Automatic hydraulic hold-downs clamp any gage metal with firm pressure. Fine adjustments for the 4-edge knives assure more efficient use of the keen edge and longer life. All standard Shear sizes, 10 gage to 1¼ inches.

A. O. SMITH ELECTRIC MOTOR for the Cincinnati Shear is 5 hp, 1800 rpm, a punch-press type with high starting torque, 8 to 13% slip—an open motor, frame 225, with prelubricated double shielded ball bearings.

A.O. Smith Century 75th ANNIVERSARY 1874 · 1949

24-HOUR MOTOR SERVICE

To more than 200 authorized service stations, A.O. Smith Product Service Division provides fast, low-cost electric-motor service, on a 24-hour, off-the-shelf basis. Factory Service Branches and Warehouses at Union, N.J., Chicago, Dallas, Los Angeles.

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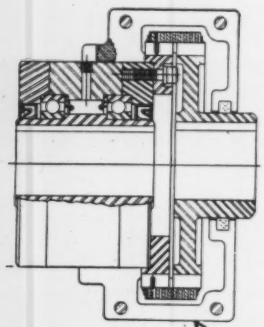
1. An unmatched line of silent and roller chain drives, clutches and couplings. Wide range of sizes, capacities and ratings in stock.
2. The economies of mass-production with automatic machinery—*a lower cost for you.*
3. Power transmission products backed by a 51-year record of specialization in precision engineering and mechanical craftsmanship.
4. The application experience of Morse Power Transmission engineers—partners in the design and development of a very great variety of products.

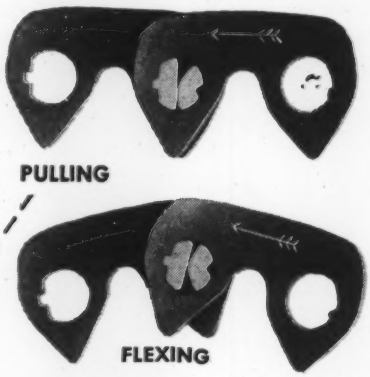
And you get the *extra margin of profit* that results from buying all your power transmission equipment from a single source—the leader in power transmission, Morse Chain Company and Morse Chain Distributors.

Keep your catalog file up-to-date! Send coupon for latest data and specifications on Morse Roller and Silent Chain Drives, Clutches, Couplings and Driveshafts.

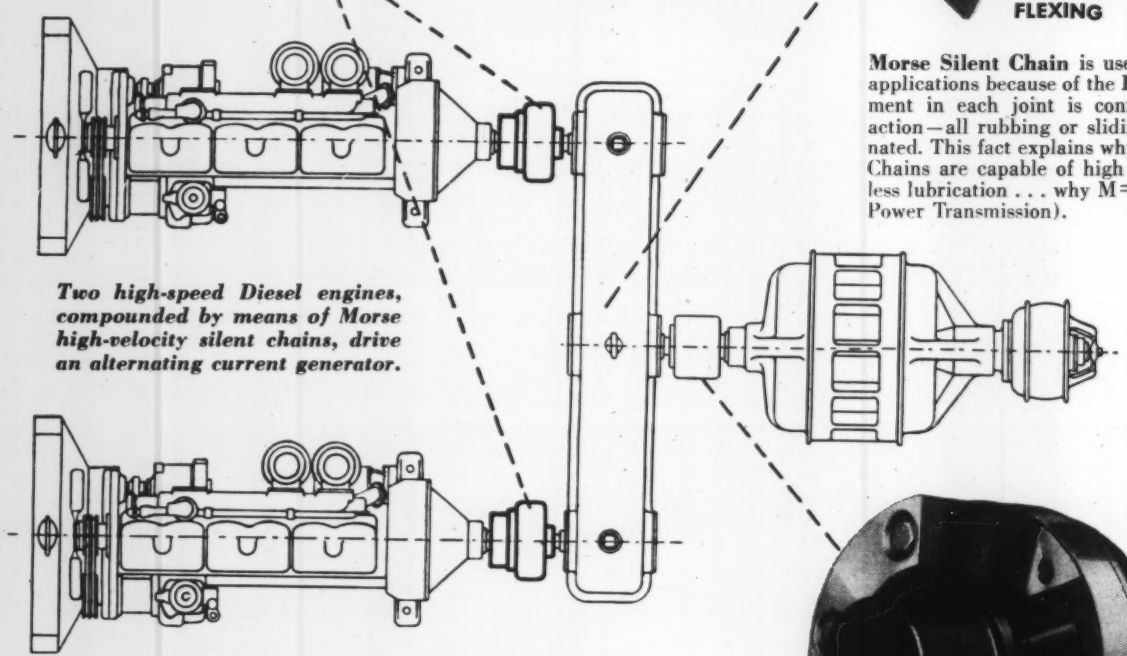
Typical Application of Morse Power Transmission Products



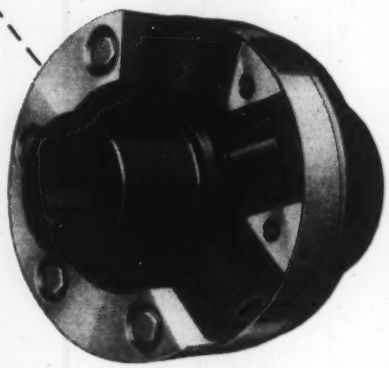
Morse-Formsprag Clutch Couplings combine full complement Morse-Formsprag over-running clutches and Morse flexible couplings. The over-running clutch automatically engages when torque is applied—disengages when torque ceases. The automatic action is instantaneous to protect equipment in the event of failure of either engine. Morse flexible couplings compensate for misalignment.



Morse Silent Chain is used on high velocity applications because of the Rocker Joint. Movement in each joint is confined to a rocking action—all rubbing or sliding motion is eliminated. This fact explains why only Morse Silent Chains are capable of high velocities—require less lubrication . . . why M=PT (Morse means Power Transmission).



Two high-speed Diesel engines, compounded by means of Morse high-velocity silent chains, drive an alternating current generator.

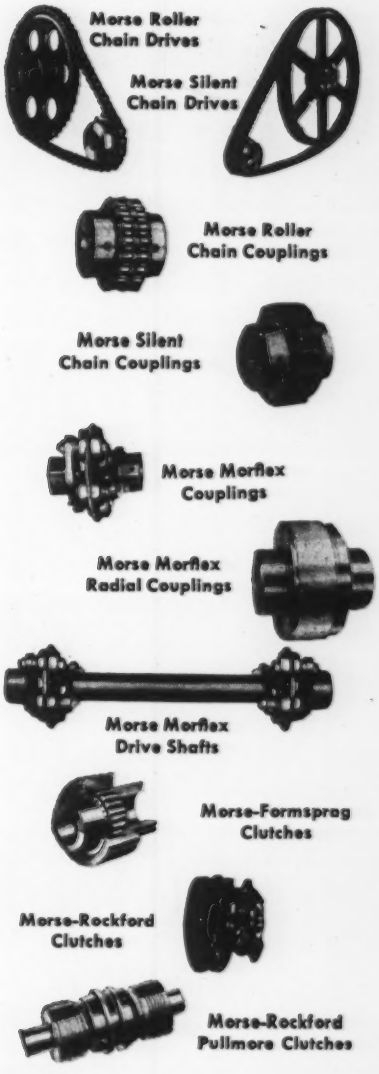


Morse Morflex Radial Couplings with resilient, preloaded rubber "biscuits" are ruggedly constructed, and torsionally flexible. Morflex Radial Couplings compensate for misalignment, absorb shock and dampen vibration. These qualities result in smooth, vibration-free power transmission. M = PT (Morse means Power Transmission).

ASK the Morse Man nearest you . . . today!

From coast to coast there are more than 100 offices, representatives and distributors of Morse Power Transmission products to give you quick information and service when you want it—where you want it. *Ask the Morse Man first in any case!* **Check your classified telephone directory under "Power Transmission" or "Chains."**

Morse means Power Transmission



MORSE

MECHANICAL POWER TRANSMISSION PRODUCTS

PRODUCTS OF B-W BORG-WARNER

Morse Chain Company
7601 Central Avenue, Dept. 421
Detroit 8, Michigan

Gentlemen:
Please send me latest technical data and specifications on:

- ☐ Roller Chains and Sprockets
- ☐ Morse Silent and Roller Chain Couplings
- ☐ Morse-Formsprag Clutches
- ☐ Silent Chains and Sprockets
- ☐ Morflex Couplings
- ☐ Morse-Rockford Clutches
- ☐ Pullmore Clutches
- ☐ Have representative call

Name_____

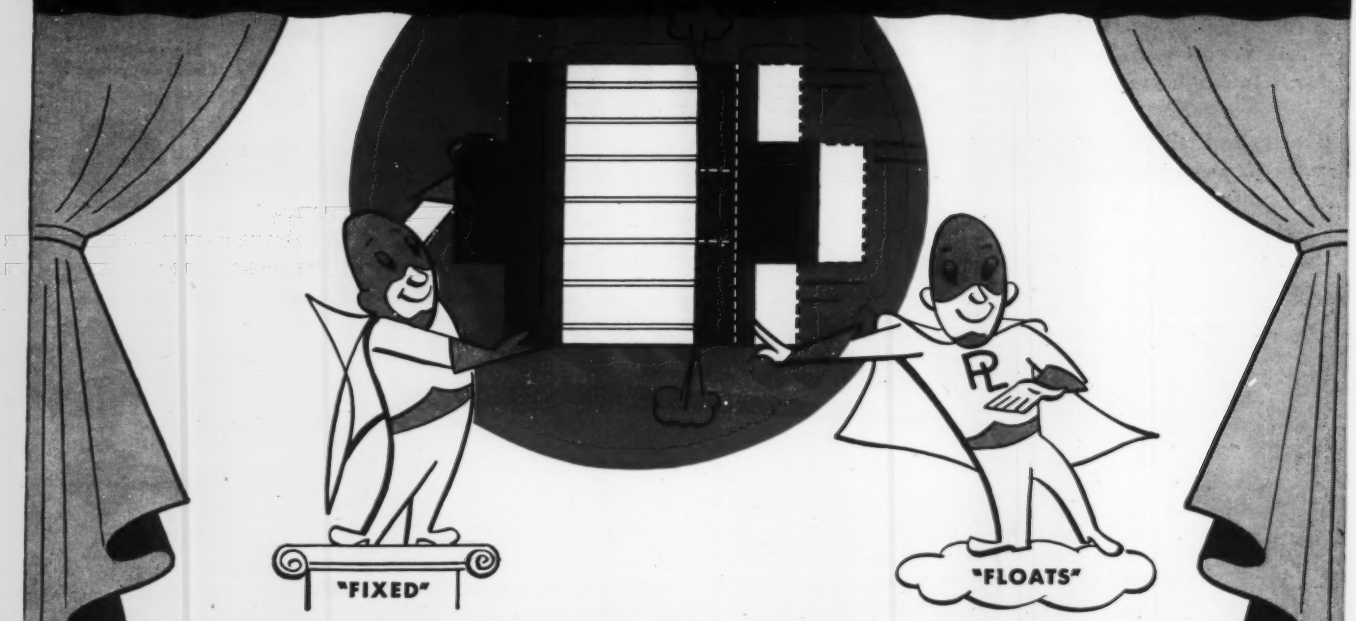
Title_____

Company_____

Address_____

City_____ Zone____ State_____

MEET THE "PL"* TWINS

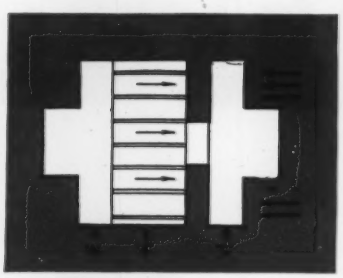


...The Greatest Little Act in Hydraulics

Yes, sir, "Fixed" and "Floats" are the famous "PL"* twins, Pesco's exclusive hydraulic pump act that provides volumetric efficiencies up to 97% . . . torque efficiencies up to 90% . . . and assures these efficiencies over a longer service life.

"Fixed" is an old-timer at this kind of an act. But it's "Floats" that really wows 'em. He's the one that *automatically* holds end clearance to a thin film of oil, making possible maximum torque and operating efficiencies under all operating conditions. Together, "Fixed" and "Floats" make possible Pesco's patented "Pressure Loading" principle of construction for gear-type hydraulic pumps. Here's their act:

*"PRESSURE LOADING"... How it works



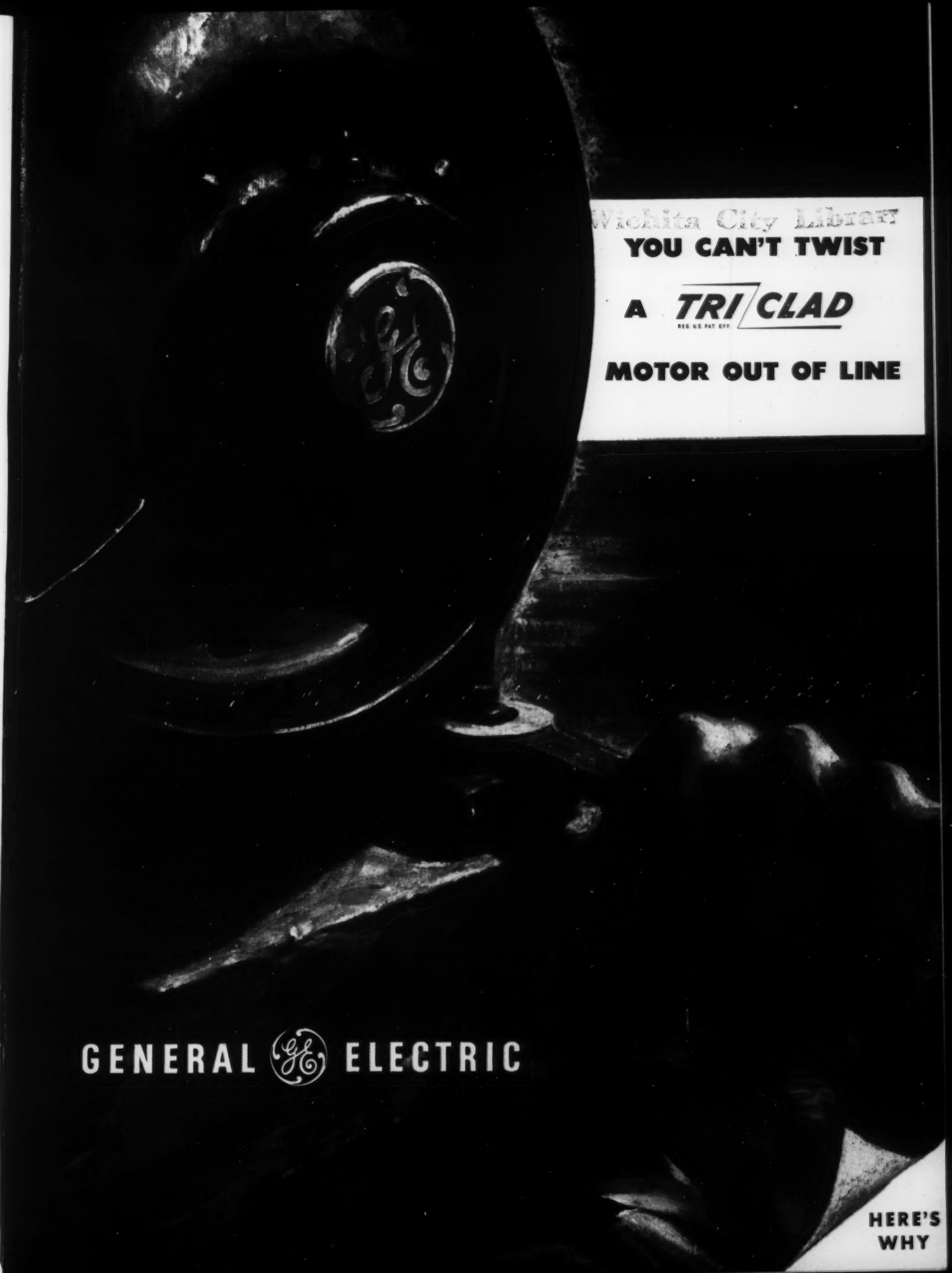
The schematic illustration at right shows the three principal parts of a gear-type hydraulic pump. They are the bearings ("A" played by "Fixed" and "C" played by "Floats") and the gear ("B"). Bearing "A" is fixed. Bearing "C" floats. By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "Pressure Loading" passage and is exerted against the rear of the "floating" bearing. This force is counter-balanced by pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.

ONLY PESCO PUMPS ARE "PRESSURE LOADED"

"Pressure Loading" may be the answer to more efficient, economical operation of your product. Why not get the full story today. Write for booklet "Pressure Loading by Pesco". No obligation, of course!

Pesco PRODUCTS DIVISION
BORG-WARNER CORPORATION
11610 Euclid Ave. · Cleveland 6, Ohio

BW MANUFACTURERS OF SUPERCHARGERS



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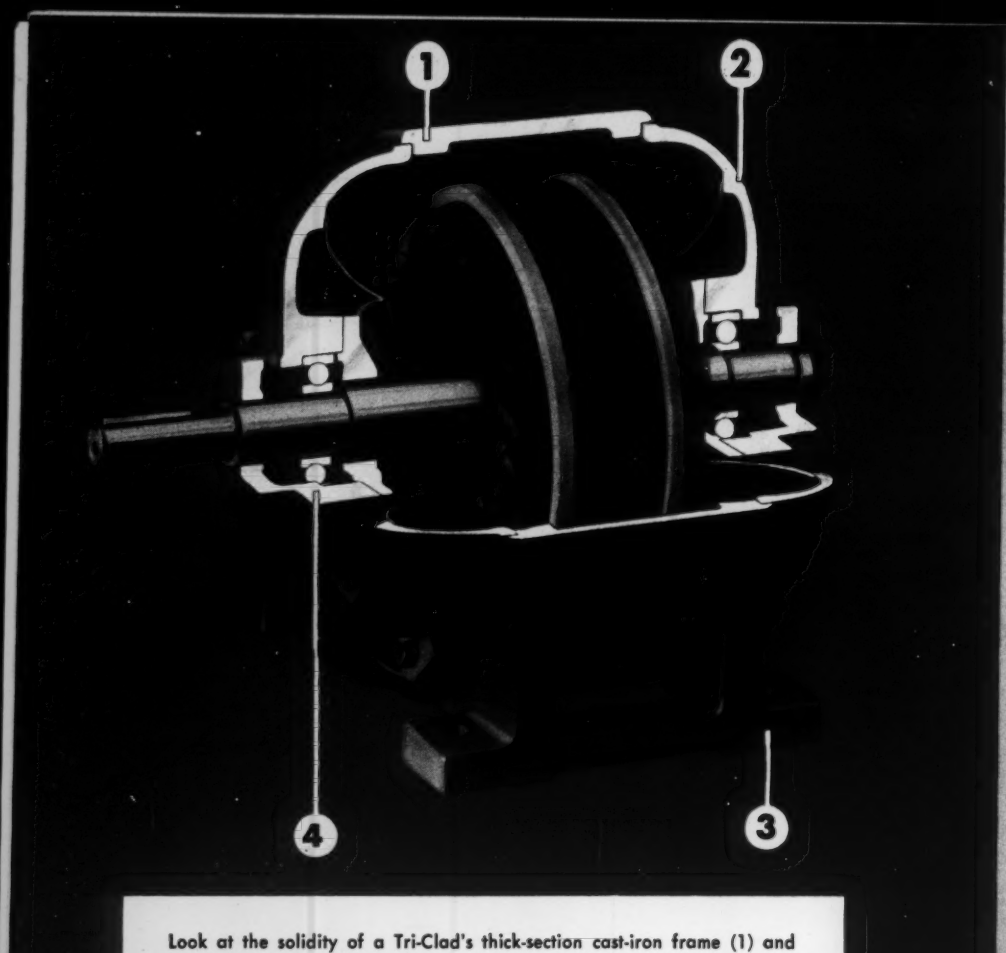


Look at the solidity of a Tri-Clad's thick-section cast-iron frame (1) and heavily reinforced end shields (2) . . . its heavy integrally cast feet (3). Do you wonder we say "Tri-Clad gives you structural strength and rigidity no other general purpose motor can match"? Notice, too, the *completely enclosed* bearings (4). A Tri-Clad motor will run safely without relubrication for years — as long as any general-purpose motor you can buy. Yet it's grease-gun easy to lubricate if you ever need to.

You can't twist a TRI CLAD motor out of line

Try as a heavy-muscled mechanic may, he can't twist a Tri-Clad motor frame when bolting it to an uneven surface. The bolt will snap before he can pull that rigid cast-iron structure out of line.

Important? It's one of the basic reasons General Electric believes cast iron to be the ideal structure for general-purpose industrial motors. Other reasons? Cast iron has unusually high resistance to rust and corrosion. It has an inherent damping action that minimizes resonance. And . . . it won't take on an injurious permanent "set" as a result of accidental blows or mechanical abuse.

Want a motor that's been **SERVICE-PROVED** in 5 billion hours of rugged industrial use? Nearly all types and ratings are **AVAILABLE FROM STOCK.**

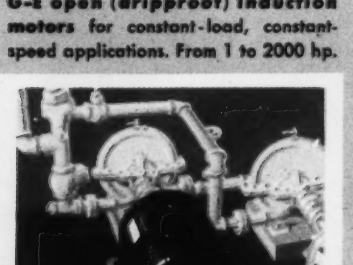
Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

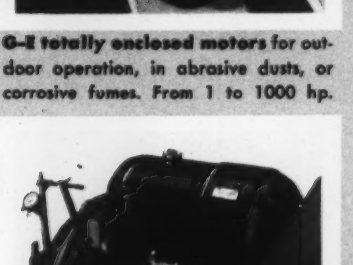
YOU CAN'T BEAT TRI CLAD
REG. U.S. PAT. OFF.

EXTRA PROTECTION

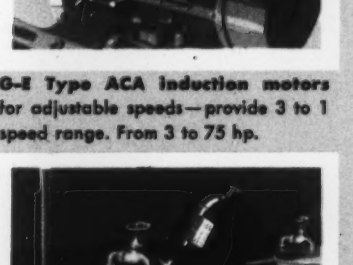
G-E open (drippproof) induction motors for constant-load, constant-speed applications. From 1 to 2000 hp.



G-E totally enclosed motors for outdoor operation, in abrasive dusts, or corrosive fumes. From 1 to 1000 hp.

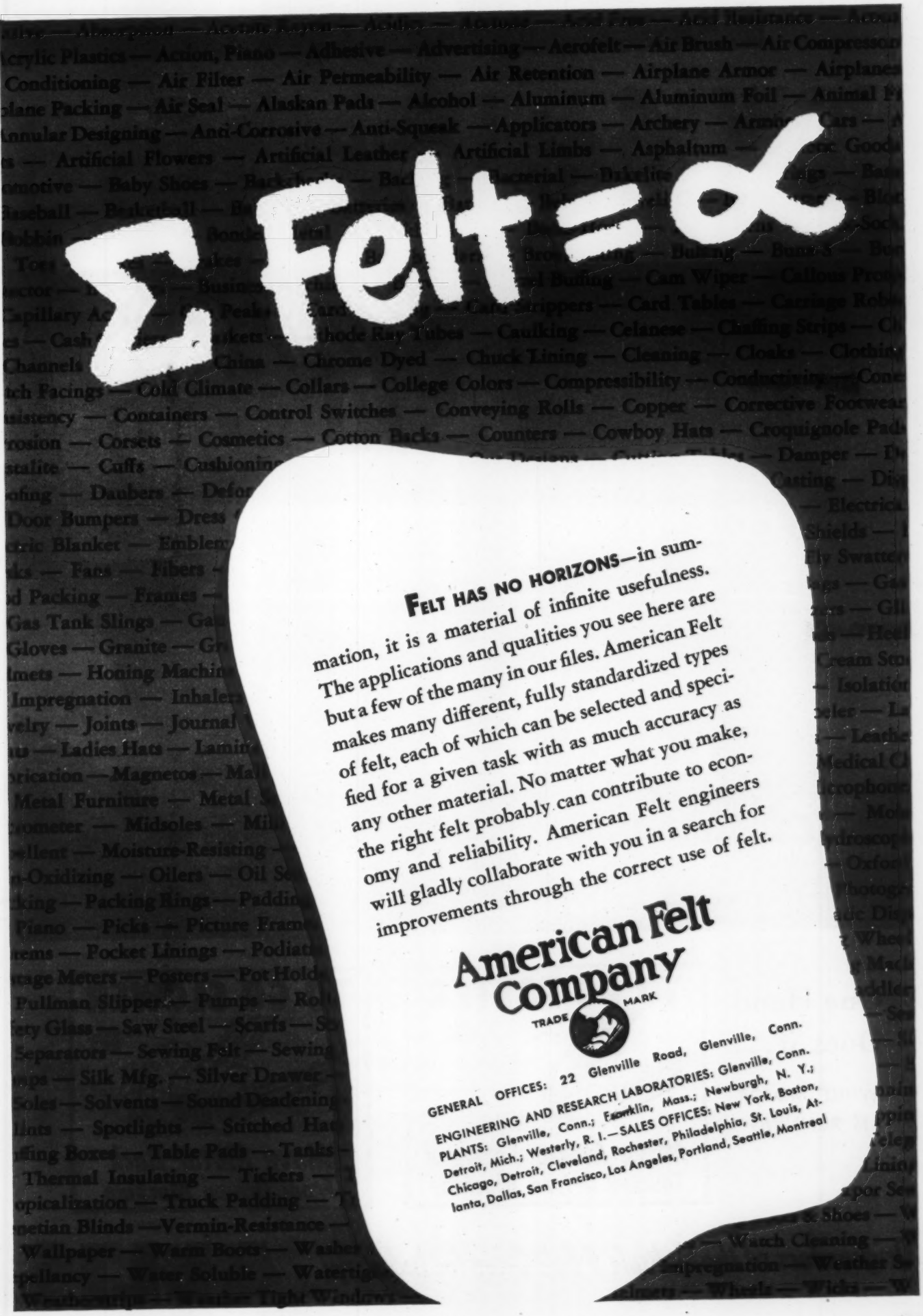


G-E Type ACA induction motors for adjustable speeds—provide 3 to 1 speed range. From 3 to 75 hp.



G-E flange and face-type motors for use where the machine supports the motor, or vice versa. From 1/20 to 60 hp.

Look for this **EXTRA** on the motor you buy!



FELT HAS NO HORIZONS—in summation, it is a material of infinite usefulness. The applications and qualities you see here are but a few of the many in our files. American Felt makes many different, fully standardized types of felt, each of which can be selected and specified for a given task with as much accuracy as any other material. No matter what you make, the right felt probably can contribute to economy and reliability. American Felt engineers will gladly collaborate with you in a search for improvements through the correct use of felt.

American Felt Company

TRADE MARK

GENERAL OFFICES: 22 Glenville Road, Glenville, Conn.
ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.
PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal

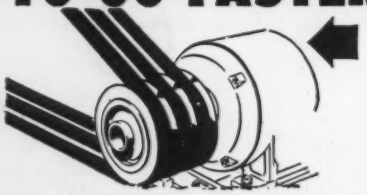
NEW TEXROPE AUTOMATIC SHEAVE

NOW.. Get Lowest Cost

One Hand Does it...

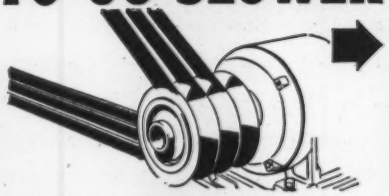
WHILE MOTOR IS RUNNING

TO GO FASTER



Move Motor Forward Toward Driven Machine

TO GO SLOWER



Move Motor Back From Driven Machine

Originators of the Multiple V-Belt Drive for Industry!

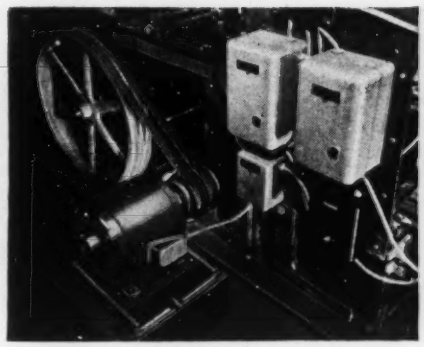
ALLIS

AIDS PRODUCT DESIGNERS

Instant Speed Control

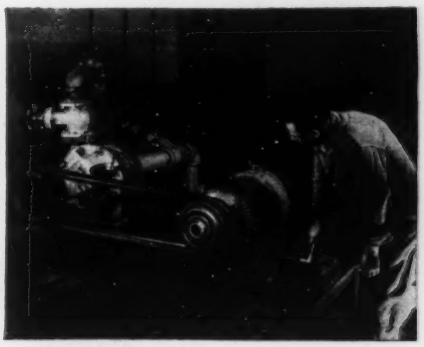
TEXTILE

AUTOMATIC SHEAVE changes speed of spinning frame in seconds while in motion. Replaces more expensive method of changing speed. Here, operator quickly obtains best operating speed to suit thread strength and size. Speed can also be changed to suit various operators.



WOOD PRODUCTS

CORING MACHINE uses automatic sheave and Allis-Chalmers induction motor and control. Instantly variable speed with 2 to 1 speed range greatly increases output at small original cost. Motor operates at 900 rpm with driven shaft speed adjustable from 120 to 228 rpm.



PUMPS

PERFECT SOLUTION to varying head and capacity of pump at same time maintaining efficiency. Where pumping requirements vary, pump can be instantly adjusted to supply more or less liquid as desired. Pump illustrated is solids handling pump driven by 10 hp enclosed motor.

MACHINE TOOLS

HIGH MACHINE PRODUCTIVITY is number one advantage of instantly adjustable Vari-Pitch Automatic drives. Constant cutting speed is now easily obtained at lowest cost for grinders, buffers and polishers . . . plus the inherent shock-absorbing advantages of Texrope V-Belts. Close control of periphery speed means higher efficiency grinding and polishing, as well as prolonged grinding wheel life.

Vari-Pitch Automatic Sheaves offer the same advantages for punch presses, engine and automatic lathes, drill presses and many other types of machine tools. Why not investigate the possibilities of using this new sheave in your product? You'll find an Allis-Chalmers Texrope drive expert at your nearby A-C Sales Office. He'll be glad to show you how Vari-Pitch Automatic Sheaves can be applied to your product.

NEW VARI-PITCH AUTOMATIC SHEAVE covers most speed changing needs from 3 to 40 horsepower . . . gives you instant *stepless* speed control for machines at lowest possible cost! It changes pitch diameter and holds belts at proper tension *automatically!* Gives you 100% speed increase; 2 to 1 range.

Machine designers and original equipment manufacturers are already using this new sheave to increase machine versatility . . . at costs only a fraction more than for other types of speed control.

Send for details on this great new advancement today. Learn how it can be applied to your problems at new lost cost. And for additional information on other A-C products for the OEM field — pumps, motors, controls, voltage regulators — check your needs in the coupon below.

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

CHALMERS

A-C ALLIS-CHALMERS

ALLIS-CHALMERS, 1001A SO. 70 ST.
MILWAUKEE, WIS.

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- Handy Guide for Electric Motors — Bulletin 5186052 ☐
- Rocking Contact Voltage Regulators —
  - Bulletin 1386035 ☐
  - Bulletin 1486143 ☐
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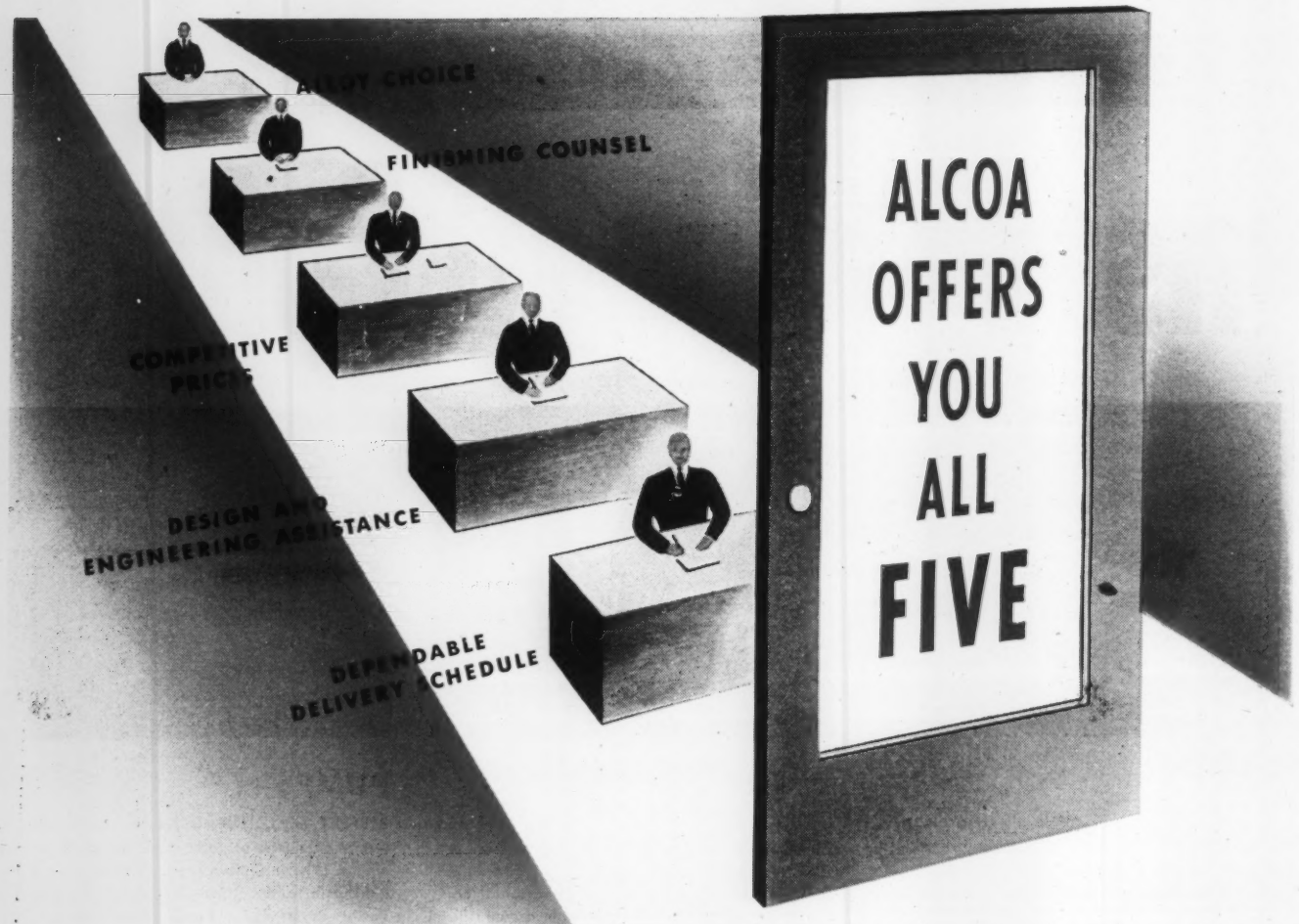

for better screw machine parts

Aluminum trained experts at Alcoa's modern screw machine products division offer you reliable advice on:

1. Choice of aluminum alloys
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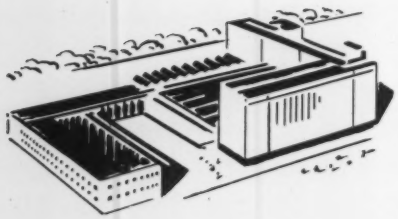

Complete facilities under one roof

You get all these with screw machine parts by Alcoa, plus the added advantages of aluminum parts: strength with light weight, close tolerances, added sales appeal, range of all commercial finishes plus Alumilite* finish exclusive with aluminum.

Your Alcoa representative will be glad to give you more facts about our service, and a prompt quotation. Or write ALUMINUM COMPANY OF AMERICA, 676J Gulf Building, Pittsburgh 19, Penna.

*Patented process

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ALCOA ALUMINUM SCREW MACHINE PRODUCTS

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
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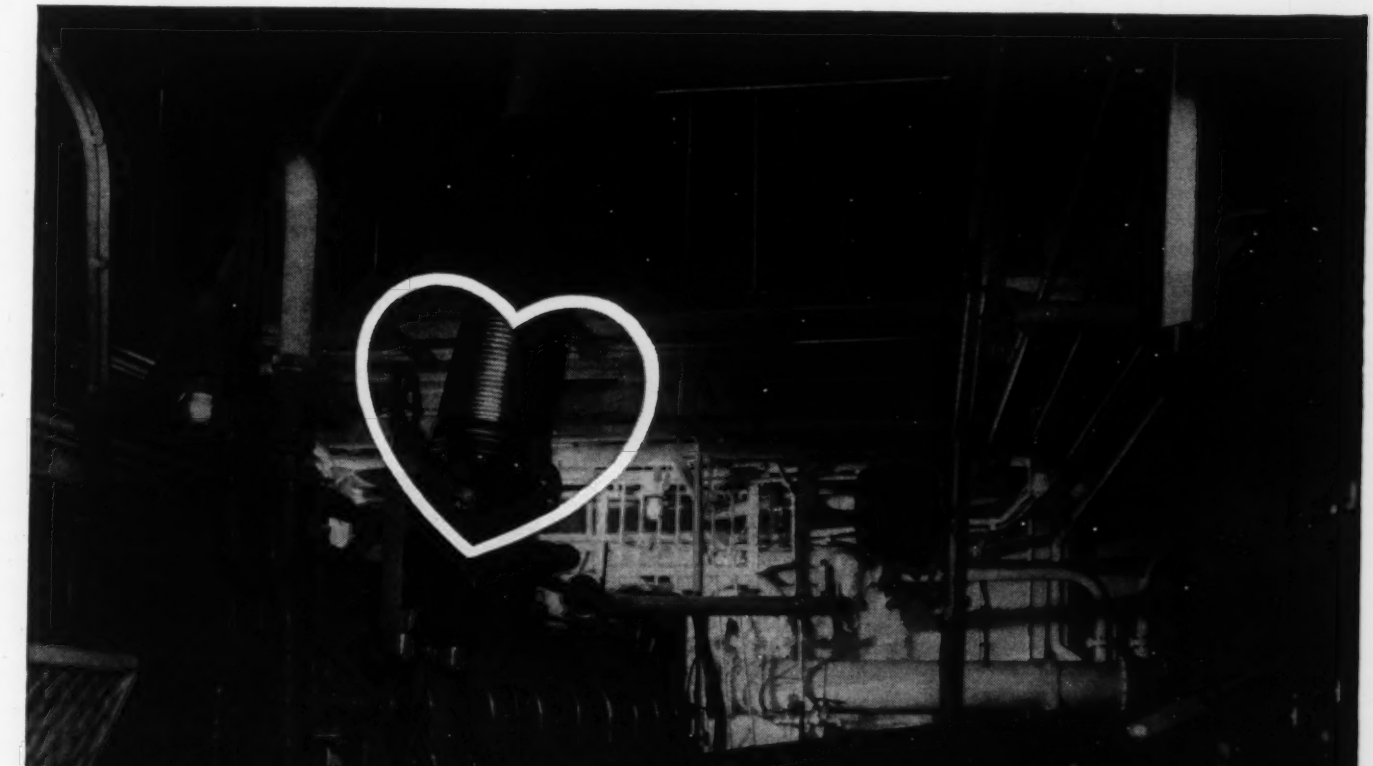


TAMES A POWER THROB

FLEXINEERING ELIMINATES VIBRATION ON TUG DIESEL EXHAUST . . . PROVIDES SMOOTHER POWER . . . COOLER OPERATION

When the giant 16 cylinder, 1750 horsepower diesel engine of the new tugboat, Grace Moran, roars into action, there's a smooth purr of silky power. And one of the keys to this vibration-free operation is "flexineering"—the scientific engineering of flexible metallic tubing to industry's specific needs.

From the exhaust to the stack is a five foot length of Penflex air jacketed 14 inch, interlocked, flexible metallic tubing which achieves a circulation of air and an efficient cooling action. Tough, rugged tubing that keeps exhausts as tight as a pipe . . . yet provides all of the flexibility necessary to "soak up" the constant vibration.

In designing products or installations, whether your problem is exhaust or air lines...the transmission of liquids, volatiles, dry granular material or coarse abrasive products...or even the protection of fine lead wires on instruments, "flexineering" has the answer for you. Penflex engineers will be glad to help in the application of tubing from 1/8 inch I. D. on up to 24 inch I. D. Write for your copy of folder "Flexineering."

PENNSYLVANIA FLEXIBLE METALLIC TUBING CO.
7239 Powers Lane **Philadelphia 42, Penna.**

Branch Sales Offices
BOSTON • NEW YORK • CLEVELAND • CHICAGO • HOUSTON • LOS ANGELES

Penflex... HEART OF INDUSTRY'S LIFE LINES

Copyright 1949—Penna. Flexible Metallic Tubing Co.

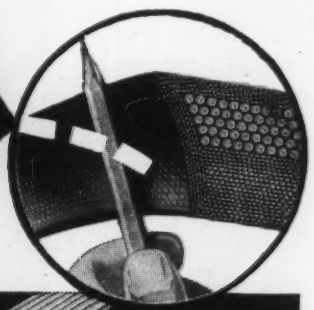
Here is Plain PROOF...

You can actually *feel* the sides of a belt *change shape* as the belt bends.

That the CONCAVE SIDE

(U. S. Patent No. 1813698)

SAVES Transmission DOLLARS

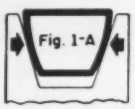


When a *straight-sided* V-Belt bends around a pulley, three things are bound to happen.

(1) The top of the belt, being under tension, *narrows.* (2) The body of the belt, under compression, *widens.* (3) The sides of the belt *bulge out.*

These *shape changes* are inevitable. They are shown in figures 1 and 1-A, below.

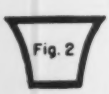
Straight-Sided V-Belt.



How Straight-Sided V-Belt Bulges in Sheave-Groove.

Because this bulging belt does not fit the sheave groove, two facts become clear. (1) The belt will get excessive wear where it bulges—*shorter life!* (2) The whole side of the belt cannot *uniformly* grip the pulley—*a loss in drive efficiency.*

How different the V-Belt with the precisely engineered *concave* side (U.S. Patent No. 1813698)—the Gates Vulco Rope. As this belt bends it assumes a shape that *exactly* fits the sheave groove. (Figures 2 and 2-A, below.)



Gates Vulco Rope with Concave Side.

No Side Bulge. Precise Fit in Sheave-Groove.

Two savings result. (1) The Gates Vulco Rope wears evenly—*longer life!* It's entire side-wall grips the pulley—no slip—*full delivery of power!*

REG. U. S. PAT. OFF.

The Mark of SPECIALIZED Research

The Concave Side is MORE IMPORTANT NOW Than Ever Before

Because the sides of a V-Belt are what actually drive the pulley it is clear that any increased load on the belt means a heavier load that must be transmitted to the pulley directly through the belt's sidewalls.

Now that Gates *SPECIALIZED* Research has made available to you SUPER Vulco Ropes—carrying fully 40% higher horsepower ratings—the life-prolonging Concave Side is naturally more important in conserving belt life today than ever before.

498

GATES VULCO ROPE DRIVES

Engineering Offices and Jobber Stocks IN ALL INDUSTRIAL CENTERS of the U. S. and 71 Foreign Countries

THE GATES RUBBER COMPANY
DENVER, U.S.A.
"The World's Largest Makers of V-Belts"

UNBRAKO

SOCKET CAP SCREW WITH KNURLED HEAD

...SLIP-PROOF HEAD
...EXTRA STRONG
...MADE TO CLOSE TOLERANCES

There is a definite saving of assembly time when you use "UNBRAKO" Socket Head Cap Screws with Knurled Heads. The exclusive knurled heads perform a triple duty: (1) the *knurling* provides a sure, slip-proof grip; (2) the *knurling* permits positive locking—a feature so often essential where there is excessive impact or vibration; (3) the *knurling* speeds assembly, because it enables the "UNBRAKO" to be screwed in easier, faster, and further with the fingers—handiest of all wrenches—before a "key" becomes necessary.

Knurling of Socket Screws originated with "Unbrako" in 1934.

As always, the name of "UNBRAKO" signifies *extra strength* and *precision manufacture to close tolerances.*

"UNBRAKO" Knurled Socket Head Cap Screws are available in sizes from #4 to 1½" diameter, and in a full range of lengths. Write for your free copy of the "UNBRAKO" Catalog and the name of your nearest "UNBRAKO" Distributor.

Other "UNBRAKO" Products include:
Socket Set Screws with Knurled Cup Points, Socket Set Screws with Knurled Threads, Square Head Set Screws with Knurled Cup Points—all patented, self-locking screws that won't shake loose! Socket Head Stripper Bolts. *Precision-Ground* Dowel Pins. *Fully-Formed* Pressure Plugs.

SPS STANDARD PRESSED STEEL CO.
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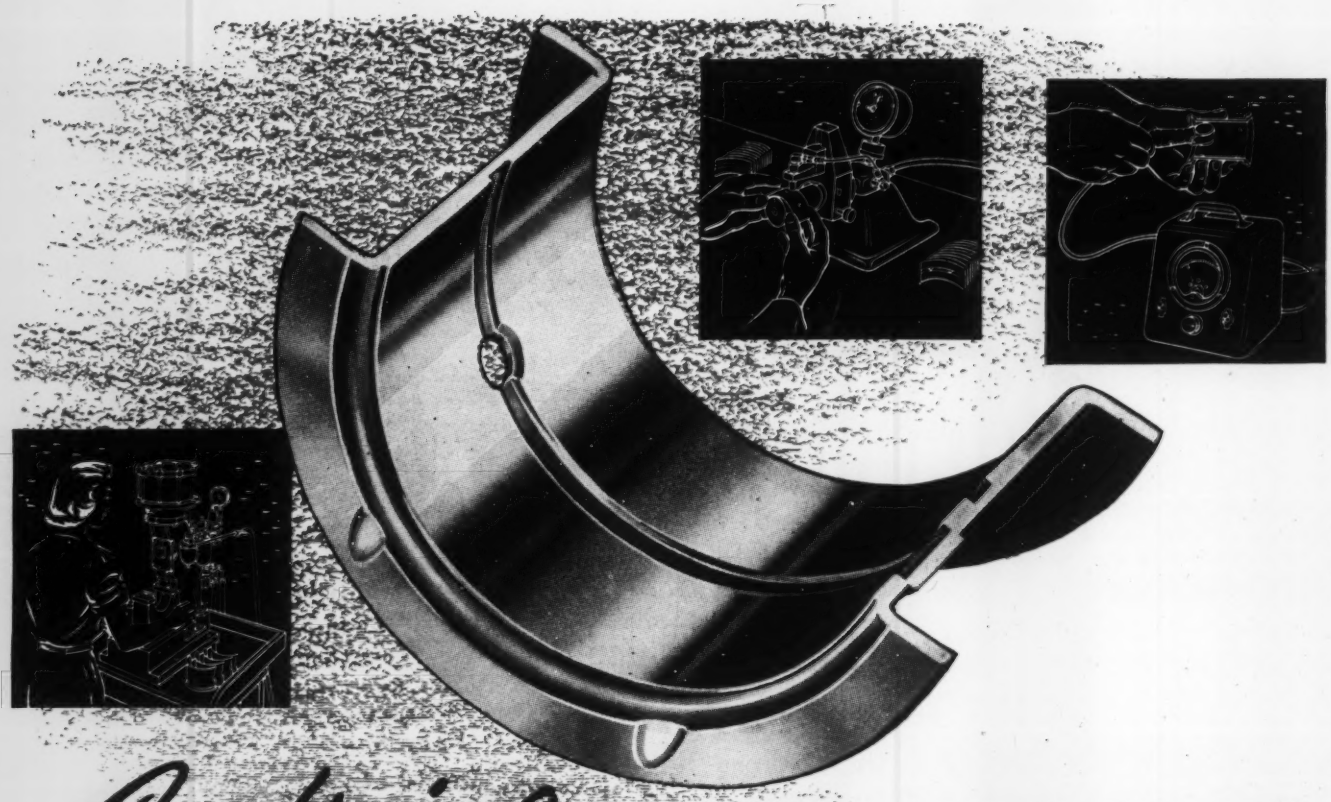
"Serving Industry continuously since 1903 through Industrial Distributors"



Combining PRODUCTION IN THE MILLIONS WITH QUALITY IN THE INDIVIDUAL BEARING

To assure top quality in mass production of sleeve bearings, at low cost, our Quality Control and Production Methods organization conducts as many as 108 separate tests for material quality and physical accuracy of the individual bearing. Specialists for almost 50 years, our six-plant organization is tailored to the peculiar needs of sleeve bearing production—from original research to field tests of the finished product. Our engineering department will gladly consult with you on your problems.

28 PRECISE MACHINE OPERATIONS

84 MEASUREMENT CHECKS

24 ADDITIONAL TESTS

are conducted on a strip-type, copper-lead lined, steel-backed flanged bearing.

HIGH SPEED, high temperature, automotive type bearings available in many combinations.

SPEED & LOAD bearings for pumps, compressors, industrial electric motors and similar uses.

HEAVY LOAD for big Diesels, power plants, etc.—bearings up to 27½" O.D., steel and bronze back.

BRONZE PARTS in many shapes, sizes; thrust washers, bushings; for many types of applications.

Power goes to work smoothly through

FEDERAL-MOGUL

FEDERAL-MOGUL CORPORATION — FEDERAL Mogul Silent SLEEVE BEARINGS — 11045 SHOEMAKER, DETROIT 13, MICH.

A PLUS FROM US TO YOU

Something extra . . . with no strings attached?

Yes indeed. We've been doing it for years, too—rough-machining our rolled-and-forged circular blanks, so that the customer won't have to do it himself in his own plant. A little thing, yes—but this extra feature is one indication of the fine overall workmanship you'll find in these products.

Bethlehem circular steel blanks have a multitude of end uses. Here are a few: spur, bevel, and miter gears; crane wheels; turbine rotors; flywheels; industrial wheels; sheave wheels; tire molds and rings, etc. They're exceptionally good for such applications, because they're strong—very strong—and they'll stand a lot of grief.

At Bethlehem, blanks of this kind are made in a mill that combines the steps of upsetting, forging, and rolling. It's a method that imparts homogeneity, good grain structure, nice surface characteristics. Because of their high strength, the blanks can often be used in thinner sections, thus saving weight. Sizes range from approximately 10 in. to 42 in., OD. You have your choice of carbon or alloy steel, and your order can be heat-treated or untreated, as you wish. And pardon if we repeat—the blanks all reach you beautifully rough-machined! For further details, including many pictures of actual applications, ask for a copy of Booklet 216.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
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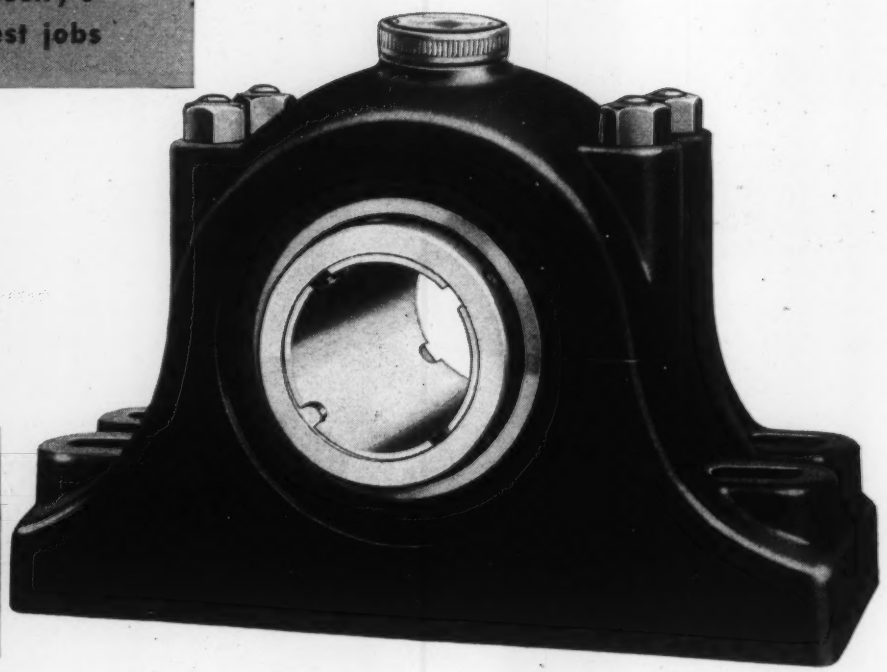
BETHLEHEM STEEL

BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

Quality-proved by use on millions of industry's toughest jobs

Mounted, sealed, housed, fully assembled, ready to lock on the shaft

Delivered from stock in 4 basic types and a vast range of sizes



"DODGE-TIMKEN" MEANS QUALITY!

It was Dodge who took the famous Timken Bearing, mounted it, sealed it, housed it and delivered a pillow block of new high quality—fully assembled, ready to lock on the shaft and carry the power loads of industry with new efficiency.

Power savings, improved machine operation, reduced maintenance, elimination of spoilage and steadier production—all result so regularly from the application of Dodge-Timken Bearings that this great line is widely accepted as the standard for comparison in up-to-date power transmission layouts.

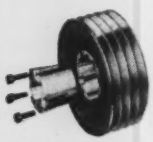
Ask the Transmissioneer, your local Dodge Distributor, how these bearings and other Dodge "firsts" can help you achieve better, more economical production.

DODGE MANUFACTURING CORPORATION, MISHAWAKA, IND.

100-TON PULL

Three Dodge-Timken Pillow Blocks carry the load of a 100-ton pull of castings in and out of a shot blast chamber for the Falk Corporation, at Milwaukee. The bearings save the gear reducer from side pull and allow the shaft to turn easily even while taking the full load. Perfect operation for 8 years to date.

OTHER DODGE "FIRSTS"



TAPER-LOCK SHEAVES
Easy on—easy off—holds fast to the shaft.

ROLLING GRIP CLUTCH
No toggles! Great flexibility—positive drive.

"SC" BALL BEARING
Pillow Block with new Neoprene metallic-backed seal.

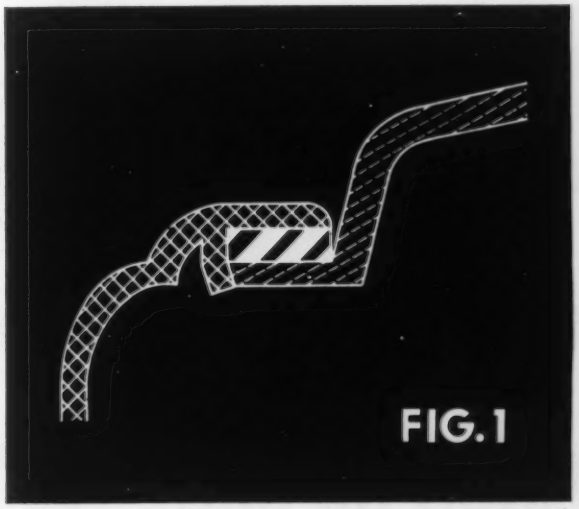
DODGE

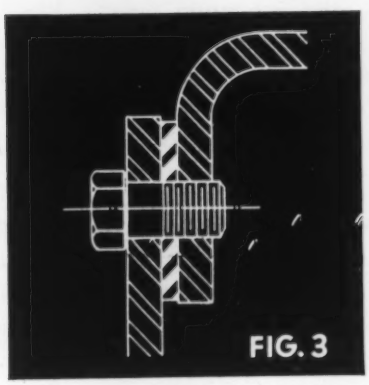
of Mishawaka, Ind.

CALL THE TRANSMISSIONEER. Look for the name of the Transmissioneer, your local Dodge distributor, under "Power Transmission Equipment" in your classified telephone directory.

FOR YOUR NAME PLATE REQUIREMENTS, WRITE OUR SUBSIDIARY, ETCHING COMPANY OF AMERICA, 1520 MONTANA STREET, CHICAGO 14, ILLINOIS

Designing joints for low-cost sealing





An effective seal at least cost is usually the result of designing the joint and its gasket as a unit. In this way, alternate types of flange construction with their appropriate gaskets can be judged against specific application requirements to determine the most economical method for sealing a given joint.

For many applications, stamped or spun metal flanges may offer attractive cost advantages. Such flanges, however, often impose severe demands on ordinary gasket materials because of their irregular surfaces, lack of rigidity, and smaller areas of contact.

In such cases, an Armstrong's Cork-and-Rubber Composition usually will provide an effective, low-cost seal. In these materials, compressible cork particles are combined with synthetic rubber to provide soft, impervious compositions that will seal irregular surfaces with relatively low bolt pressures.

In figure 1, for example, a molded plastic lens and crimped die-cast flange are sealed against weather. The soft cork-and-rubber composition seals tightly by conforming to surface irregularities in both the flange and the lens.

To seal the rolled edge tank and pressed steel cover shown in figure 2, a somewhat firmer cork-and-rubber composition was chosen. Truly compressible cork-and-rubber seats firmly on the rolled edge to provide a tight seal. The exposed cork particles provide added friction, so the gasket won't tend to slip out of place.

Cork-and-rubber, likewise, provides an effective low-cost seal in the assembly shown in figure 3. The gasket not only seals tightly between the flanges, but it also fits snugly around the bolts to prevent seepage.

Gaskets made from an Armstrong's Cork-and-Rubber Composition may provide similar savings for you. Your Armstrong representative will be glad to give you details.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

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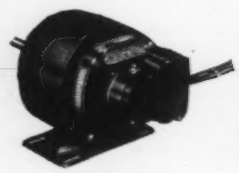
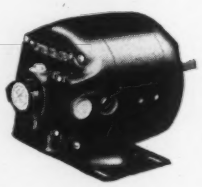
Designer's

What do you need in a fractional-hp motor?

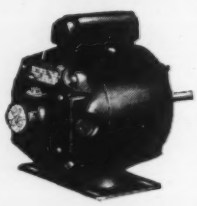


. . . operation on polyphase power? Here it is—the General Electric Type K induction motor for any standard application with polyphase power supply. Use it for pumps, compressors, fans and blowers—wherever the motor must deliver constant speed for long periods. Also available are totally-enclosed motors for machine tools.

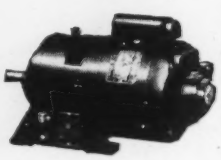


. . . operation on d-c power? When the power supply is d-c, use the General Electric Type BC direct-current motor for either constant or adjustable speed. Like all G-E motors, it's quality-built to help sell your product.

. . . constant speed and moderate torque, single phase? Specify this General Electric Type KH split-phase motor for fans, blowers, oil burners, domestic laundry equipment, office appliances, or for general use wherever low-cost operation and quiet, smooth performance are required.



. . . quick starts under load, single phase? Answer the need for high starting torque with a General Electric Type KC capacitor-start motor. It's ideal for motorized tools, domestic water pumping, and commercial refrigeration.



. . . low speed? The wide range of General Electric fractional-horsepower motors also includes compact, easy-to-mount gear-motors (illustrated) for low-speed applications. In addition, there are unit-bearing motors for minimum maintenance, series motor parts for "built-in" power, and many definite-purpose motors.

***New!* An up-to-date fractional-hp motor review** In this booklet, of special interest to machinery manufacturers, you'll find described practically every standard G-E fractional-hp motor made. It contains helpful information on motor selection, operation and construction, plus a list of almost 40 bulletins covering detailed data on individual types. Send for it now—Bulletin GEA-5174.

GENERAL ELECTRIC

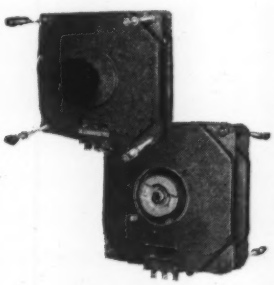
Digest PRODUCT HIGHLIGHTS

KEEPS RECORDS

photoelectrically!

Direct currents, as well as temperature, speed, pressure, thickness, light and vibration can all be recorded with this versatile General Electric photoelectric recorder. Both the deflection and potentiometer types, using minimum energy, provide direct ink records for quick analysis. Sensitivities are as low as 1.0 microampere full scale, and responses as fast as ¼ second for full-scale deflection. For portable use or semi-flush mounting. See Bulletin GEC-254.

LETS YOU ADJUST SPEEDS



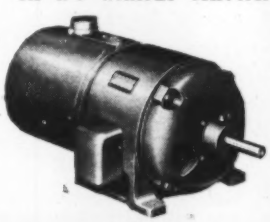
accurately!

New! For speed control of d-c motors, or voltage control of generators and exciters, you'll want a General Electric plate-type field rheostat. Accuracy of adjustment is provided by many resistance divisions—27, 52, and 70 in the 6- 9- and 12-inch sizes respectively. Adjustable stops may be located at any position between ends of travel. Open (illustrated) and totally enclosed types are made for front or back-of-board mounting. See Bulletin GEC-487.

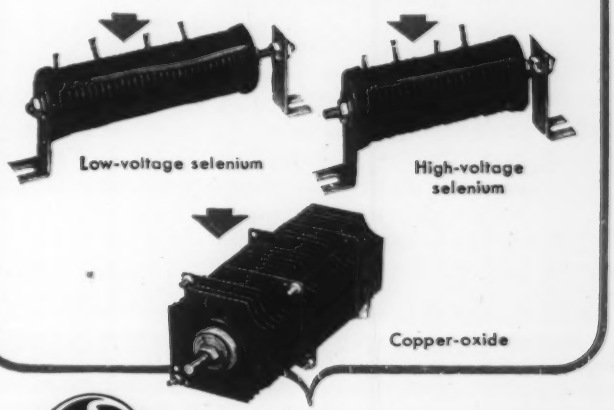
20-to-1 SPEED RANGE

in an a-c motor!

Here's a truly convenient adjustable-speed induction motor—the General Electric Tri-Clad Type ACA—that you can run on a-c without conversion equipment. A turn of the dial, and you get *any* speed over a range of 3 to 1, 6 to 1, or (for intermittent loads) even 20 to 1. And you can get it through remote control, too, with a flexible cable or pilot motor. Do you have possible applications for an adjustable-speed motor with these speed ranges? Write us for specific information, and check Bulletin GEA-4883.



WHEN A-C WON'T DO
choose one of these



METALLIC RECTIFIERS

Where you need small amounts of d-c—for example in electroplating, electrolysis protection, blocking relays in control circuits, circuit breaker operation, or power supply for magnetic chucks—get it conveniently from an a-c power source with a General Electric metallic rectifier. To fully meet your needs, General Electric makes all three types, each with special advantages for particular applications. A new, high-voltage selenium type is now available for use where high efficiency, uniformity and space economy are "musts." See Bulletin GEA-5280.

General Electric Company, Section F668-75
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

( ) GEA-4883—Type ACA Tri-Clad Motor
( ) GEA-5174—Fractional-hp motors
( ) GEA-5280—High-voltage selenium rectifier
( ) GEC-254—Photoelectric recorder
( ) GEC-487—Plate-type field rheostat

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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Topics

EXCHANGE PLAN for single-phase and three-phase motors obviates stocking replacement motors in the plant. Designed to minimize inconvenience if motor failure occurs, this Westinghouse Electric Corp. plan provides for immediate exchange at any company warehouse for a motor of identical rating. Depending on the type of failure, the service ranges from no charge to a flat or small charge at a considerable savings over a new motor.

RIBBON SOLDER, flux-coated, is particularly adaptable where soldering at low temperatures is desirable, such as in the electronics and television fields. This ribbon, developed by Proved Products Mfg. Co., requires little skill in application. In a splice, for instance, the ribbon is merely wrapped around the wire and the heat of a common match is sufficient for a perfect bond.

ELECTRONIC DEVICE, developed by Salford Electrical Instruments Ltd., Salford, England, gives a quick and accurate method of testing watches and clocks. Indication is on the screen of a cathode ray tube, a spot moving in a clockwise or counterclockwise direction when the clock is running fast or slow. Rate of movement of the spot checks the inaccuracy of the timepiece.

SYNTHETIC RUBBER applications utilize 450,000 tons on an annual basis, evidencing industry's willingness to employ these materials. This consumption is more than double the amount specified by Government order and is a tribute to the advances made in chemical research.

PROTECTIVE COATING for metal parts has been developed by Clear Glass Products Ltd., Southampton, England. Known as Avigel 100, this cheap coating is applied by brush or spray without heating and may be easily stripped when desired, protecting any metal against most forms of corrosion.

CELSIUS has been adopted as the name for the Centigrade temperature scale by the General Conference on Weights and Measures held in October, 1948, according to a recent report from the National Bureau of Standards. In the interest of eventual uniformity of practice the use of "Celsius" appears desirable but it is not practicable to impose this term on those who prefer "Centigrade". Celsius is analogous to the names Kelvin, Fahrenheit, Reaumur, and Rankine used for other temperature scales.

GLASS for television tube screens, known as Teleglas, makes possible the maintenance of an approximate 35 to 1 contrast under widely varying conditons of room light. Developed by the Pittsburgh Plate Glass Co., it is the first practically colorless glass the company has ever manufactured which was designed especially to provide less than a maximum of transmitted light. It acts as a filter to reduce the detrimental effects of room light and to minimize halation.

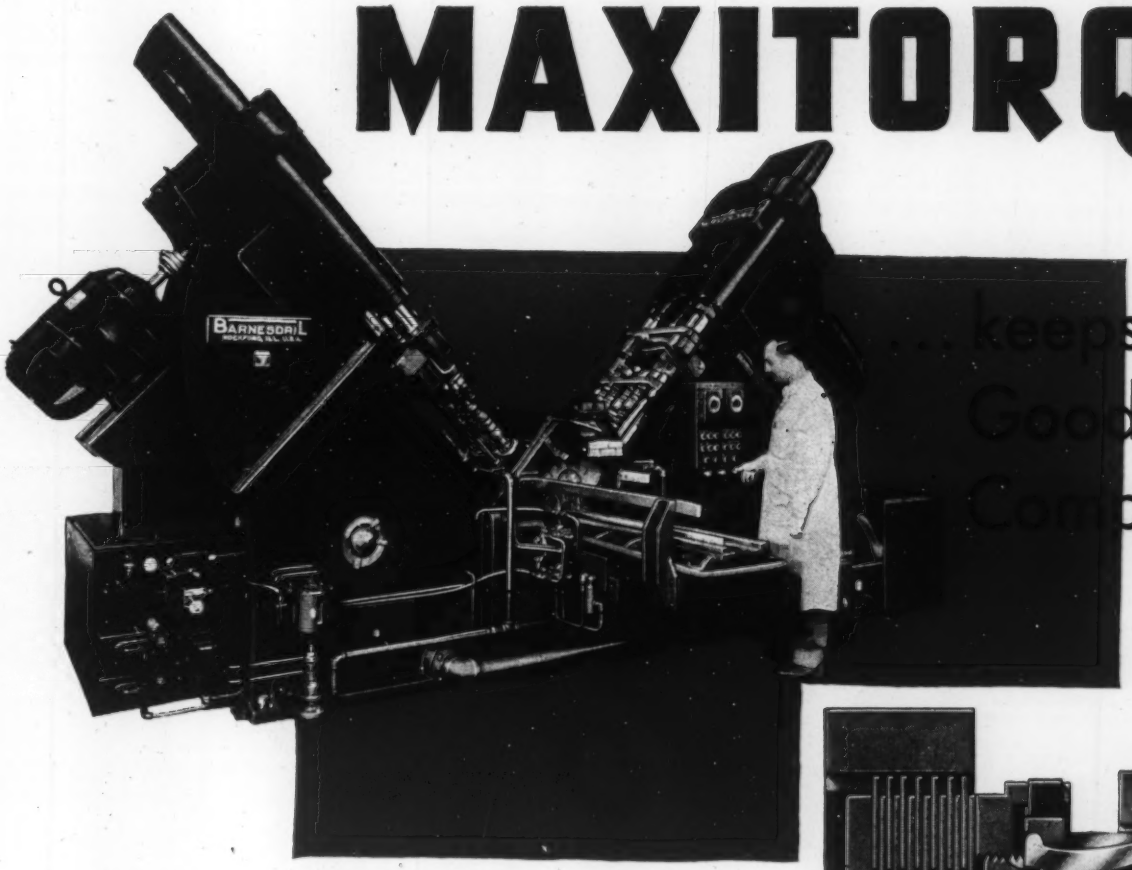
ALUMINUM is employed for over 90 per cent of the new Twin Coach bus, resulting in a 41-passenger coach which weighs 13,500 pounds compared with 19,000 pounds for steel construction. Aluminum castings are used extensively in the suspension system.

ELEVATOR MODEL responding to voice signals for its control instead of the usual push-buttons was built recently by Westinghouse to demonstrate the "uncanny alertness" that engineers are building into elevator controls.

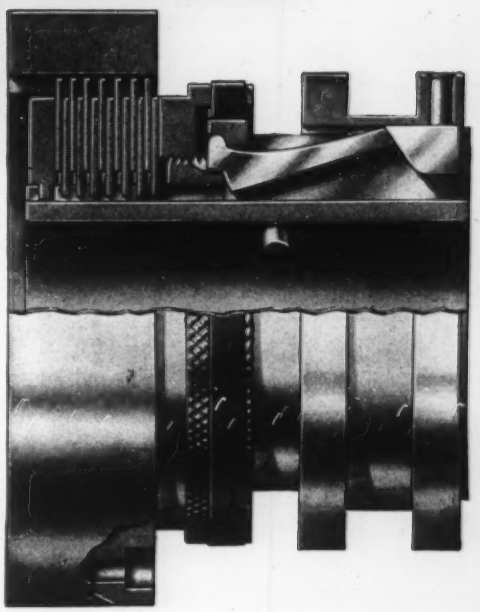
TECHNICAL SERVICE to consumers of tin will be provided free from the Tin Research Institute Inc., Columbus 1, Ohio. The new corporation was formed by the Tin Research Institute in London, England.

FLUORESCENT street lighting, being developed by the General Electric Co., appears to be particularly well suited for tunnels, bridges, viaducts and airport approaches where lights mounted at shoulder level are desirable. For street lighting two pairs of eight-foot-long lamps, almost entirely concealed from the motorist's view, are mounted in two highly polished reflectors which direct the light through clear plastic windows to the pavement.

MAXITORQ



. . . keeps
Good
Company



Today we express our appreciation to Barnes Drill Co., Rockford, Illinois, for *their* appreciation of our Maxitorq Clutch . . . selected as original equipment on the Barnesdril 320 Honing machines.

In each head a double Maxitorq is used . . . one side for engaging the spindle, the other side as a brake to stop spindle rotation.

Machine and Product designers will discover in Maxitorq the design and quality features that are so successfully controlling power transmission on nationally known Machine Tools, Textile, Packaging, Labeling, Printing, Mining and other machinery . . . and for a diversity of products like Lift Trucks, Cranes, Mowers, Polishers, Saw Mills, etc.

Maxitorq Clutches are shipped completely assembled, ready to slip onto a shaft . . . no tools required for adjustment, take-apart or assembly. Discs ride free in neutral, preventing drag, abrasion, heating. Capacities to 15 H.P. at 100 r.p.m., single or double, wet or dry.

Investigate . . . join our "Good Company" users.

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BCJ49

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TUNE IN "SUSPENSE!"
CBS RADIO NETWORK THURSDAYS
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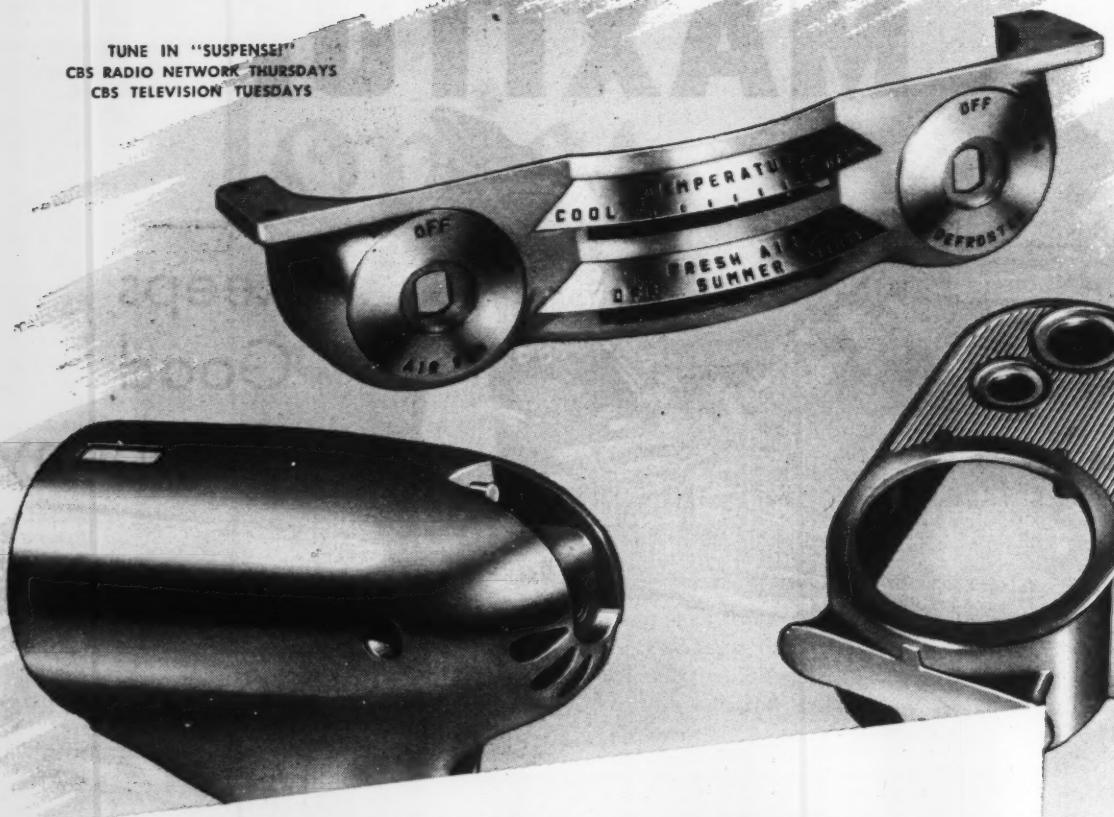

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● Increased production facilities for die castings made possible through the famous Auto-Lite "controlled metals" processes are now available. The opening of the great new Lockland plant of Auto-Lite, combined with the enlarged facilities at Woodstock, Illinois, greatly increases Auto-Lite's ability to furnish high quality die castings.

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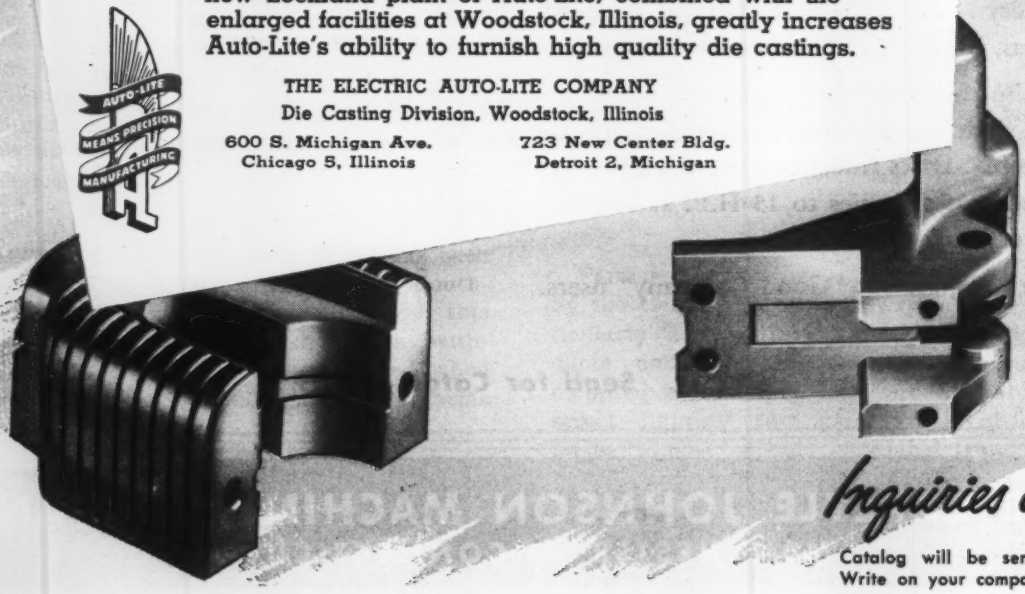


Inquiries invited

Catalog will be sent on request.
Write on your company letterhead.

MACHINE DESIGN
A PENTON PUBLICATION

What of the Next Twenty Years?

WITH this issue MACHINE DESIGN celebrates its twentieth anniversary. When the first number appeared in September 1929 many of the principles, materials, machines, and processes which are now commonplace were either in their infancy or entirely unheard of. For instance, the science of electronics, then an important factor in communications, had not yet made an impression on the machinery field, and the principles of radar and jet propulsion were still years away from any practical application. Engineering materials which could withstand high stress at temperatures approaching white heat were scarcely imagined, and powder metallurgy was a specialized process largely confined to the manufacture of filaments for electric light bulbs, and porous metal bearings.

On the Editorial page of the first issue of MACHINE DESIGN Thomas A. Edison was quoted as saying that mechanization was still in its infancy, from which the Editor concluded that "instead of having entered the machine age, we are now at its threshold," going on to say:

"Already traditional conceptions regarding the invention, development, production and sale of machines are being modified. . . . Manifestations of these new developments are appearing in machine design. Barriers that have existed for many years are being broken down to afford the profession more freedom of action. . . . . The outcome of these tendencies is that machine design becomes the focal point of many activities. It is the clearing house where the fruits of discovery, invention and research meet the experience of applied mechanics."

The progress which it has been MACHINE DESIGN's privilege to record as well as to stimulate can be attributed in no small degree to the acceptance of machine design as the "focal point of many activities." We shall not venture to predict what the next twenty years will bring in new inventions and developments for the improvement of man's lot throughout the world. But of this we can be sure—progress will be in direct proportion to the degree of leadership assumed by machine designers, the men whose job it is to translate visions into reality.

Colin Carmichael

EDITOR

Lens

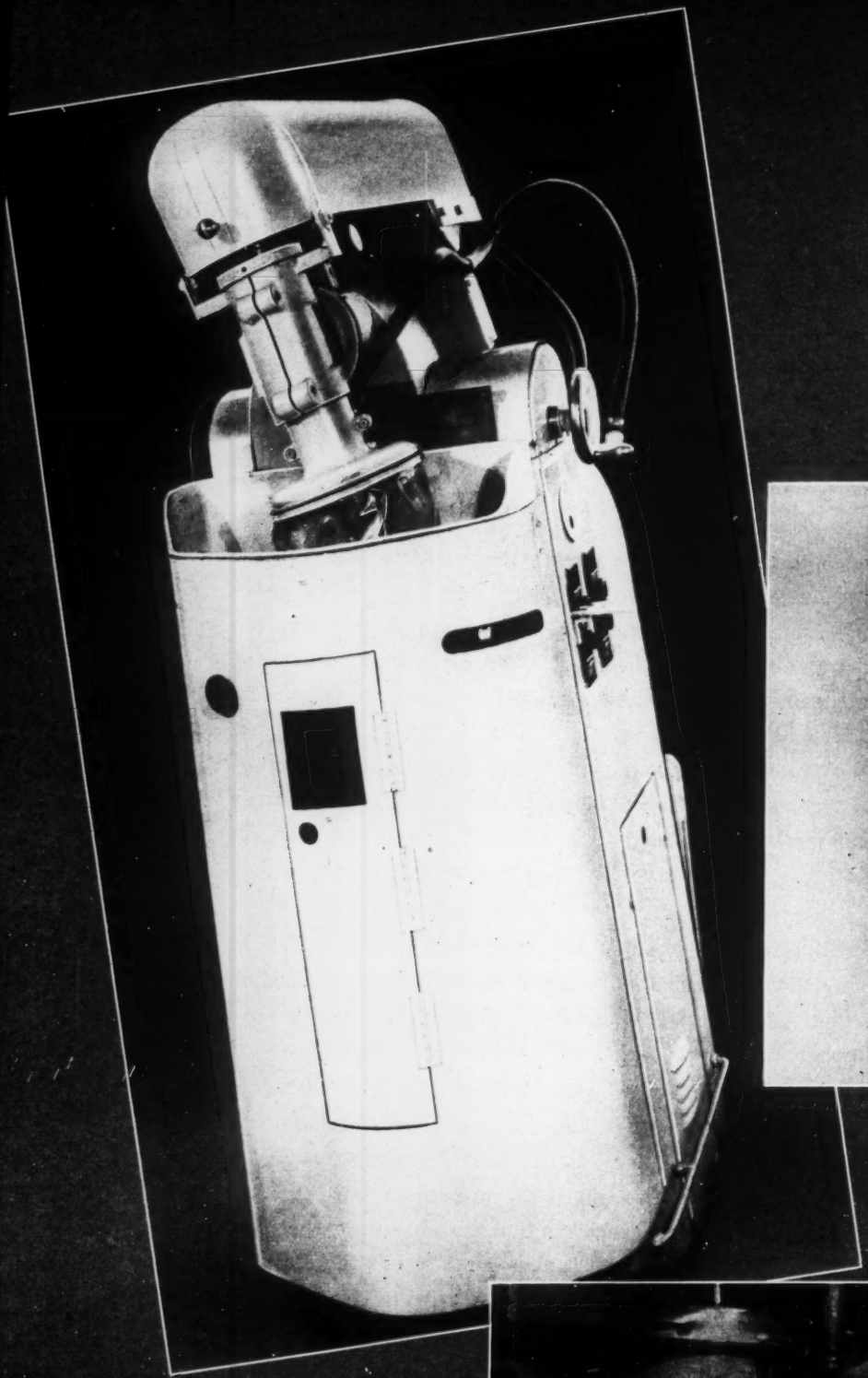


Fig. 1—Above—Spherical generator gives uniformity of lens surface and thickness as well as increasing production speed over former methods

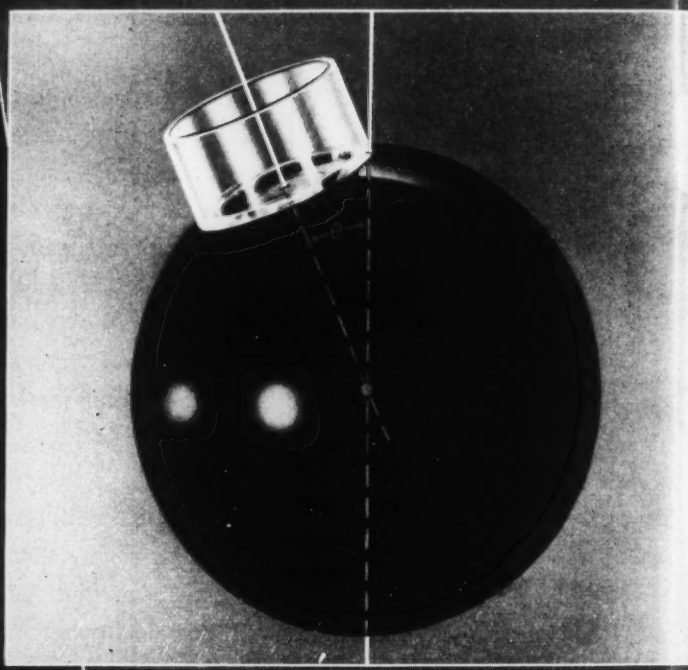


Fig. 3—Above—Principle of generating a spherical surface with a ring tool. Diameter of cylinder and angle between its axis of rotation and that of sphere determine curvature generated

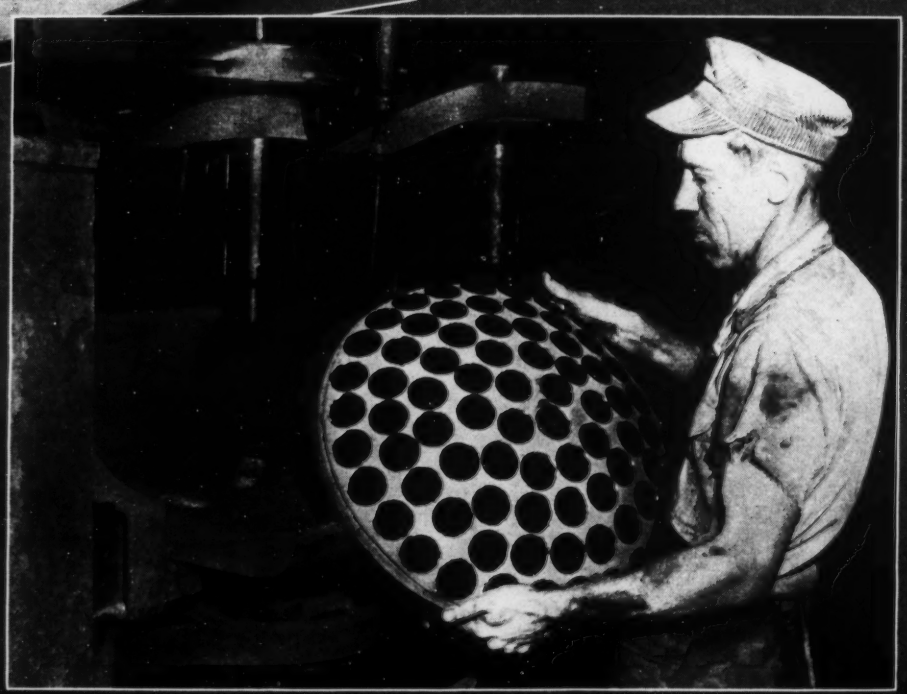


Fig. 2—Right—Typical heavy lapping shell used on former method of processing. These shells required frequent corrections to maintain accuracy of work

Grinder...
Generates Accurate Spherical Surfaces

By William P. Wier Jr.
Process Engineer

and

Carl F. Weber
Chief Machine Designer

Bausch & Lomb Optical Co.
Rochester, N. Y.

MECHANIZATION of opthalmic lens grinding, long a dream of optics manufacturers, has become a reality through development of the special machine shown in *Fig.* 1. Unlike the painstaking hand methods of the past, this machine obviates the use of loose abrasives, using metal-bonded diamond tools in their stead.

Past practice had been based on the use of heavy lapping shells, *Fig.* 2, pitch being used to hold the lenses in place, and multiple stages of grinding and polishing. This required the transfer of the heavy shells from one spindle to another. Too, the lapping shells or plates required frequent correction to maintain accuracy. Although not a direct cost of the operation, it was an indirect cost of no small proportions.

During the early 1930's, advancements in the field of powder metallurgy and grinding wheel manufacturing techniques led to the development of the metal-bonded diamond tools for grinding carbide-tipped metal cutting tools. An outgrowth of this application developed when this type of diamond grinding tool was applied to the manufacture of optical elements for military instruments in an effort to increase their production. Performance of the tools proved to be uniform and economical.

Before designing the spherical lens generator, however, a comprehensive development program was undertaken to gain fundamental knowledge of efficient operating conditions for diamond tools. The data obtained on tool performance was utilized to advantage in the design and operation of this machine.

Broad objectives for the design of the machine and for the process were set up as a goal and are as follows:

1. Give the operator working conditions superior to those existing in the optical industry generally prior to this time
2. Make possible precise measurement control over all physical dimensions of the lenses
3. Reduce costs to a point where the manufacturer would receive a reasonable return on the investment
4. Maintain sequential flow, reduce handling costs and process inventories

All this was to be accomplished at a cost of installation and operation consistent with economical amortization practice.

Generating spherical surfaces on lens blanks rapidly and consistently, this machine must generate the curves with precision because all subsequent operations must interlock exactly to result in high quality lenses.

Generating spherical surfaces on lens blanks rapid-tools is not new. Many machines have been available in the past for doing this type of work. Success of this process is due to the extension and refinement of former practices, and the application of automatic operation and precision controls into a thoroughly engineered and integrated process.

Method of Generation

Principles of ring-tool generation, on which the machine shown in *Fig.* 1 is based, can be readily visualized. Picture a sphere rotatable about an axis and a thin-wall hollow cylinder rotatable about its axis with the cylinder so positioned that its rim entirely contacts the surface of the sphere. A point on the rim of the cylinder coincides with a point on the sphere where its axis pierces the surface as illustrated in *Fig.* 3. This is the generating position as exemplified in the actual machine. It can be seen that the axis of the cylinder, if extended, will pass through the center of the sphere. This is a prime requisite of spherical generation.

Rotating the sphere about its axis while maintaining the cylinder in its original position will not change the location of the cylinder's axis with respect to the center of the sphere unless irregularities, lying on the spherical segment spanned by the cylinder, cause the cylinder to tip. If the cylinder has its posi-

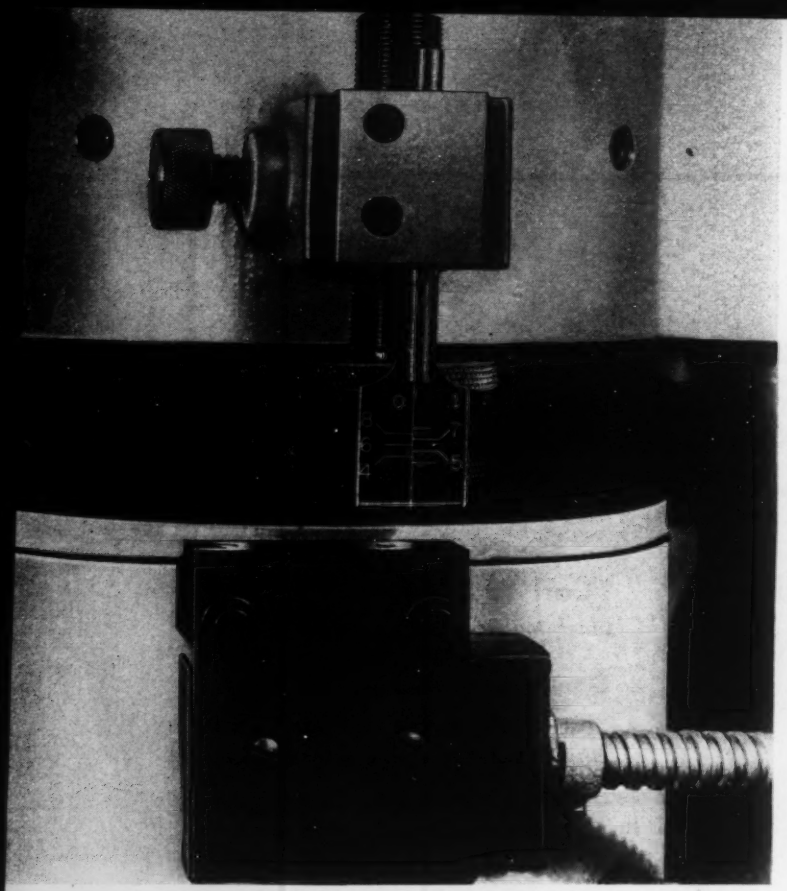


Fig. 4—Micrometer stop screw determines lens thickness

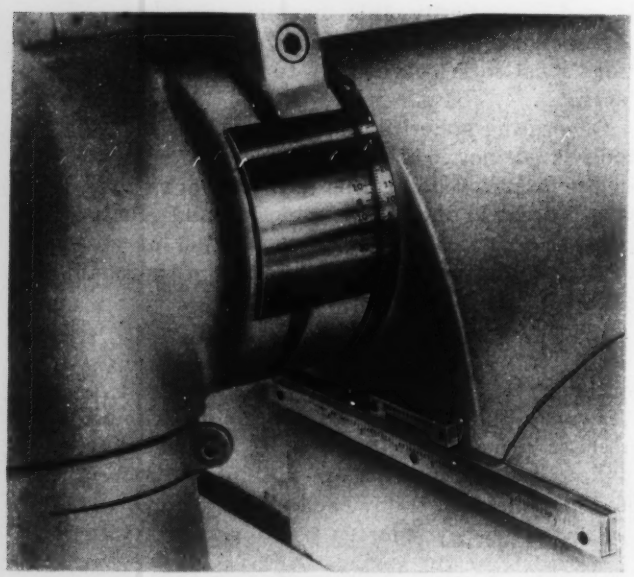


Fig. 5—Verniers for making machine settings. Angular setting is accurate to a minute of arc and lateral setting to a thousandth-inch

tion rigidly maintained and the rim impregnated with an abrasive and rotated, then any irregularities on the surface of the spherical segment that tend to tip the cylinder would be ground away thus restoring the surface of the segment to a true section of a sphere.

Diameter of the cylinder and angle θ determine the radius of curvature generated on a spherical segment. If the diameter of the sphere in *Fig.* 3 were increased and the diameter of the cylinder remained the same while maintaining the same relative position of cylinder rim to sphere axis, then angle θ would become smaller. In actual practice the diameter of the cylinder is kept constant and the radii of curvature are controlled by varying angle θ.

Diamond Wheel Is Ring Tool

If the sphere is replaced with a spindle which has a lens chuck mounted in its top and the thin-walled hollow cylinder is replaced with a diamond wheel mounted on a high-speed spindle, the basic design is obtained for the spherical generator. With a lens blank in the chuck, the spindle moves up along its axis, rotating at the same time, until the lens blank contacts the diamond wheel which is rotating at a high speed. It can be visualized that feeding the lens blank against the diamond wheel results only in grinding away glass, thus reducing the thickness of the lens blank. It is well to point out that in order to generate a curve over the entire surface of the lens blank, the blank can be no larger (and preferably less) in diameter than twice the length of the diameter of the diamond wheel projected onto a plane normal to the work spindle axis.

Positions of the cylinder relative to the sphere's axis, other than the one described, can be used for generating spheres. These alternative positions are better used on highly specialized equipment which would be more limited in range of work both in relation to size of work and radius of curvature to be generated.

Being set up to produce a specific curve by making angular and lateral settings of the top spindle, the machine is adjusted with settings taken from a prepared chart. Thickness is set by a micrometer stop screw, *Fig.* 4, mounted on the base, limiting the height to which the bottom spindle may rise. In view of the fact that close dimensional control must be maintained if modern mass production methods are to be successful, all scales used in making the settings carry verniers, *Fig.* 5.

Verniers Aid in Settings

Angular setting can be made to one minute of arc and the lateral setting can be made to 0.001-inch. A trial piece is run and measured with a spherometer which measures the radius of curvature to 0.0002-inch and surface accuracy to 0.0001-inch. The settings are then readjusted and the run started. Periodic checks are made on the curve so that the machine may be adjusted for wheel wear.

Cycle of operation is as follows: The operator places a lens blank in a mechanical chuck and actuates two starting buttons which are in series. These two starting buttons necessitating the use of both hands, make it impossible for the machine cycle to start while the operator has a hand near the grinding wheel. When the start buttons are depressed the bottom spindle, carrying the lens in its chuck, rotates at 200 rpm and rises. The motivating force for

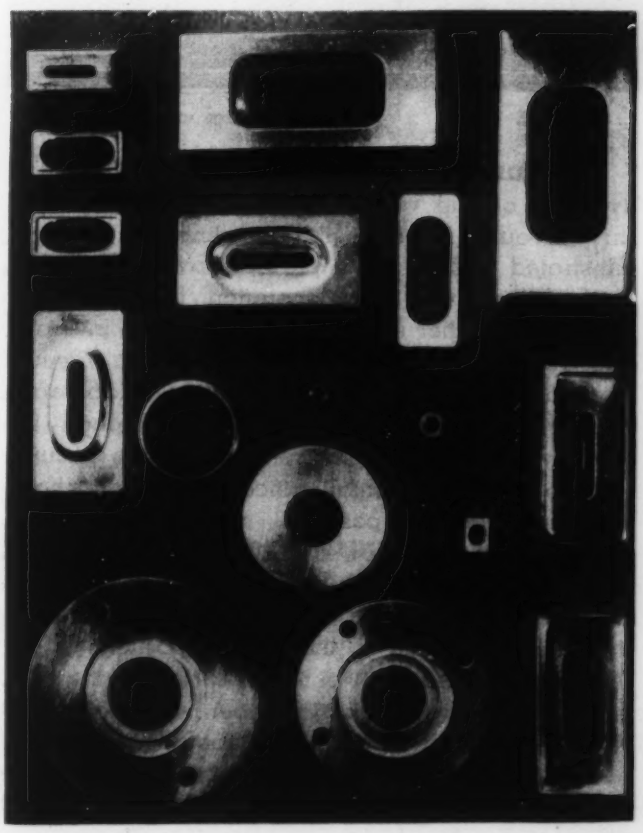
(*Continued on Page* 178)

SCANNING the Field For Ideas

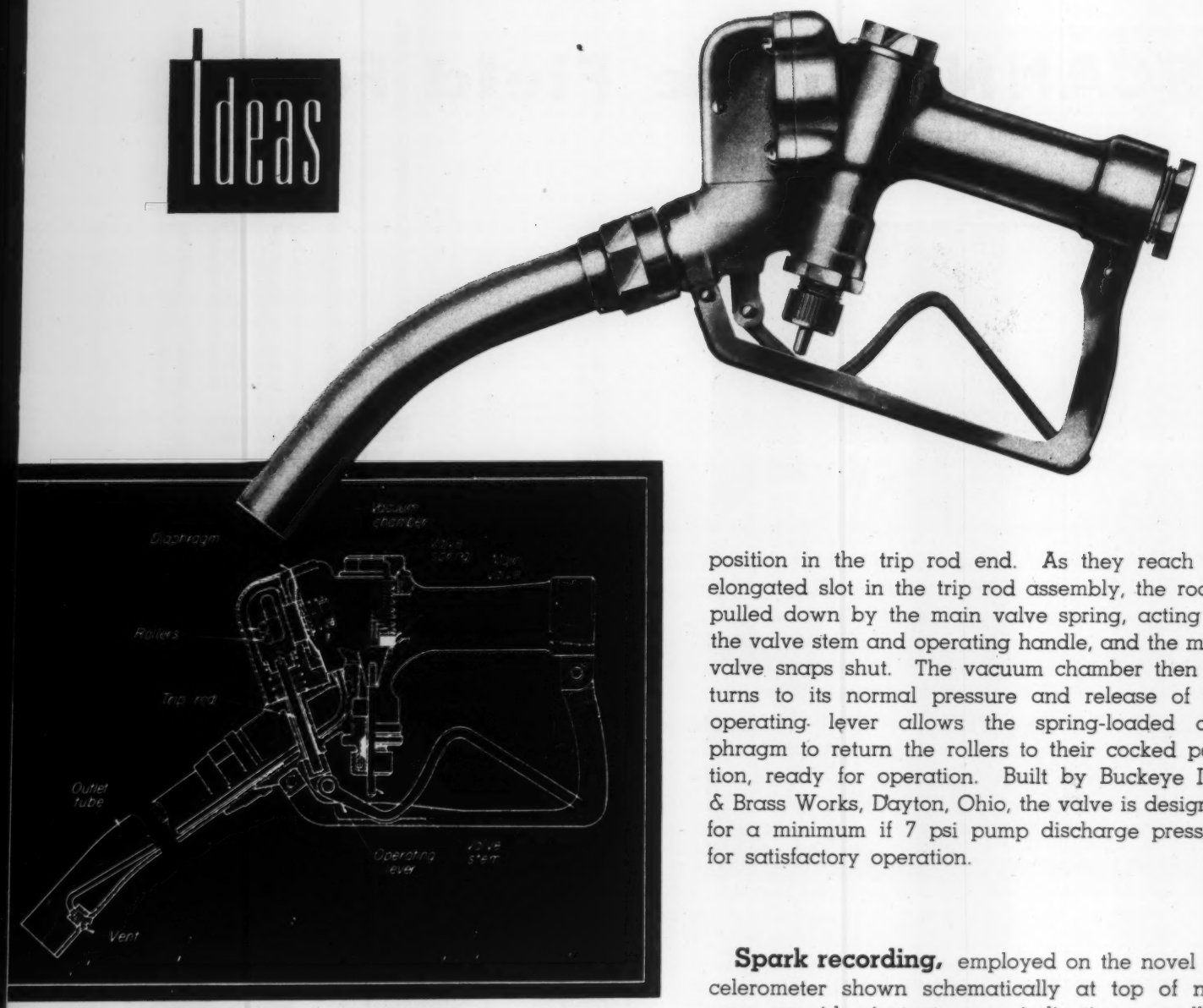
Etching process, to prepare metal surfaces for microscopic examination and photography, developed by the Ford Motor Co., is unique in that it utilizes ionized atoms. Known as cathodic vacuum etching, it enables the taking of unusually clear photographs of flow lines resulting from high-pressure forging operations. The metal sample is placed in a partial vacuum with argon gas as illustrated above. Twelve thousand volts of electricity are charged into the vacuum, creating argon-ions which bombard the metal surface and knock off minute particles.

Comparison of the structure pattern produced by the best chemical etching method revealed that the new cathodic treatment brings out the true microstructure of the metal with greater detail and clarity. For example, a special pressure-rolled Ford front-wheel spindle showed no superficial layer of flowed metal when examined experimentally by the usual microscopic technique. Cathodic bombardment etching, however, revealed the entire superficially rolled structure, showing individual flow lines which indicated that deformation was only 0.005-inch deep.

Glass windows, below, designed to permit silver soldering without damage to microwave guide systems have been developed by Sylvania Products Inc. Elimination of bending stress in the window glass is the result of applied research work done by Messrs. Martin, Pease and Roberts of the company's electronics division in which glass and Kovar have been combined through the use of special sealing techniques. Dimensional tolerances of the windows range from plus or minus 0.005-inch to plus or minus 0.0005-inch. Glass tolerances vary from 0.001 to 0.0001-inch. Glass-metal seal strength is increased by beveling one or both sides of the Kovar section.



Ideas



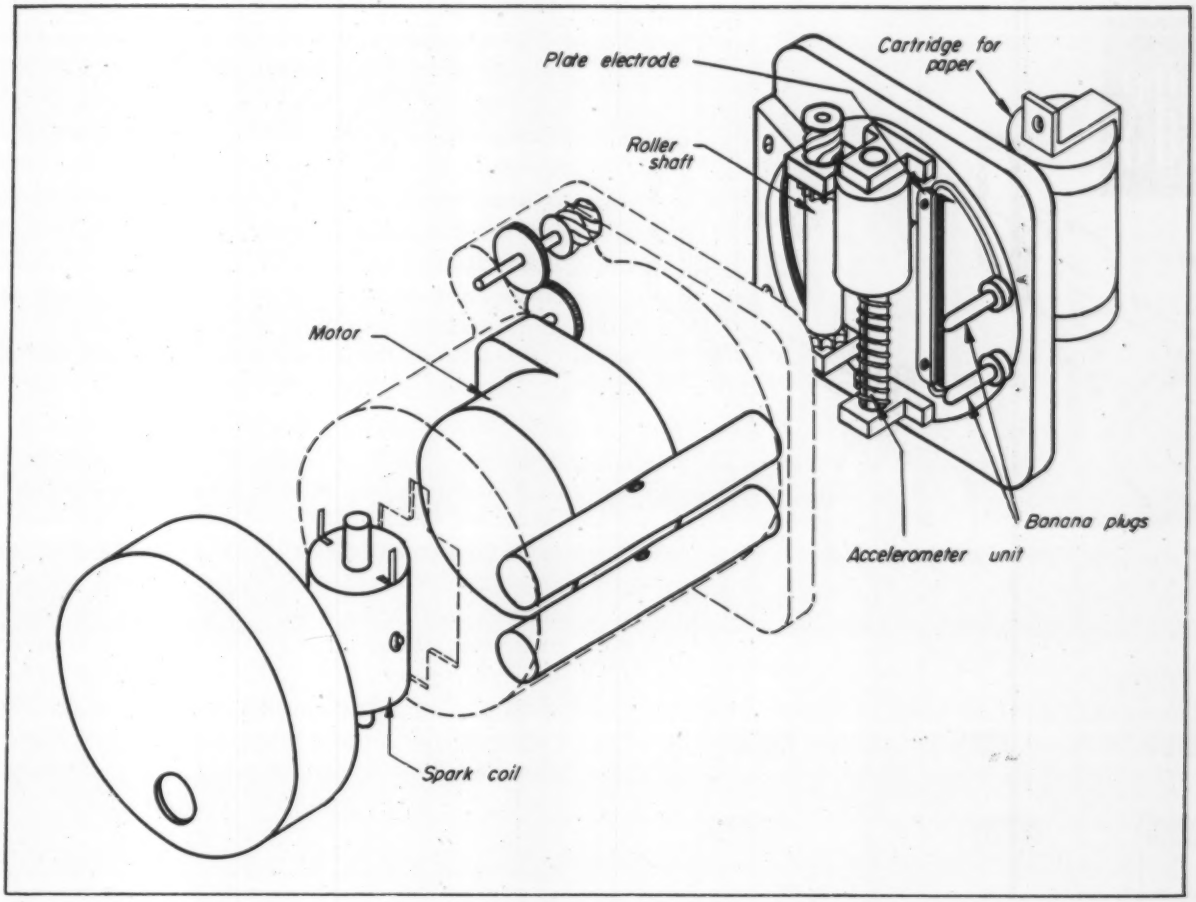
Vacuum-actuated diaphragm automatically shuts off the valve when fluid reaches a vent in the outlet tube of the gasoline-pump nozzle illustrated above. This prevents overflow of fuel tanks during the filling operation, freeing the attendant for other servicing. Vent shown in drawing, above, is connected by tubing to a vacuum chamber behind the spring-loaded diaphragm. Venturi action of gasoline flowing through the main valve decreases the pressure in the vacuum chamber through a small orifice between the chamber and gasoline passage. At the same time, fresh air enters the lower end of the vent tube and replaces the air being drawn out of the vacuum chamber, preventing a drop in pressure and keeping the diaphragm in the cocked positon.

When the fluid level in the tank rises to the vent, flow of air to the vacuum chamber is stopped, causing a pressure drop in the chamber. With this decrease in pressure, the diaphragm moves to the right pulling two rollers with it from their cocked position in the trip rod end. As they reach the elongated slot in the trip rod assembly, the rod is pulled down by the main valve spring, acting on the valve stem and operating handle, and the main valve snaps shut. The vacuum chamber then returns to its normal pressure and release of the operating lever allows the spring-loaded diaphragm to return the rollers to their cocked position, ready for operation. Built by Buckeye Iron & Brass Works, Dayton, Ohio, the valve is designed for a minimum if 7 psi pump discharge pressure for satisfactory operation.

Spark recording, employed on the novel accelerometer shown schematically at top of next page, provides instantaneous indication as well as a readily available record on a paper chart. Developed for the U. S. Air Force by the National Bureau of Standards, the unit fits into a standard rate-of-climb indicator case and withstands shock and vibration of at least 15g, making it suitable for mounting on aircraft instrument panels.

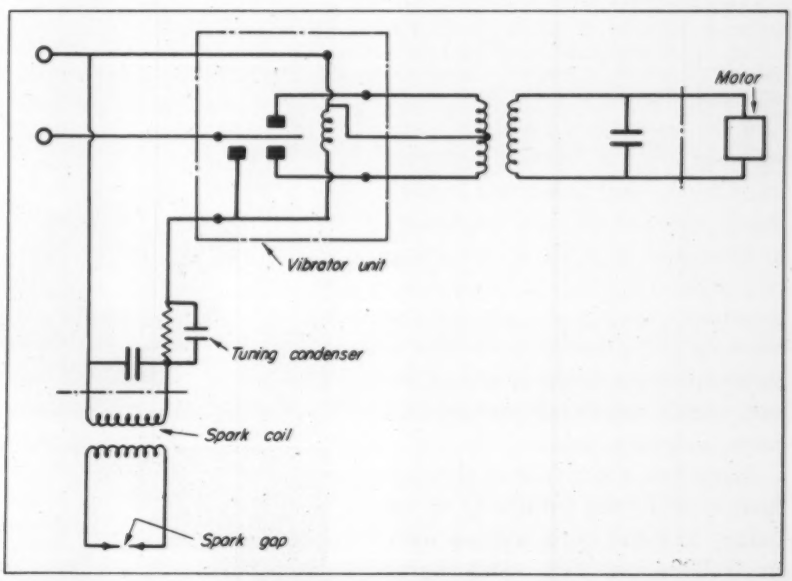
Mounted on a shaft and restrained by a helical spring, a sliding bob serves as the acceleration-sensitive device. Varying displacements of the bob from its rest position is permanently recorded on the chart by a repetitive high-voltage spark occurring at the position of the bob. Instantaneous indication is obtained because the punctured record paper is visible through the transparent front of the case.

Power from a small synchronous timing motor drives a roller shaft which feeds the paper through the instrument. As the paper passes across the face of the instrument it is punctured by sparks at a 60-cycle repetitive rate. The writing electrodes consist of a nickel tip projecting from the bob and the edge of a narrow strip mounted on the inside



of the cover directly over the nickel tip. High voltage is provided by a small spark coil, current being brought to the bob through insulated banana plugs so that removal of the cover for loading the record will cut off voltage to the electrodes.

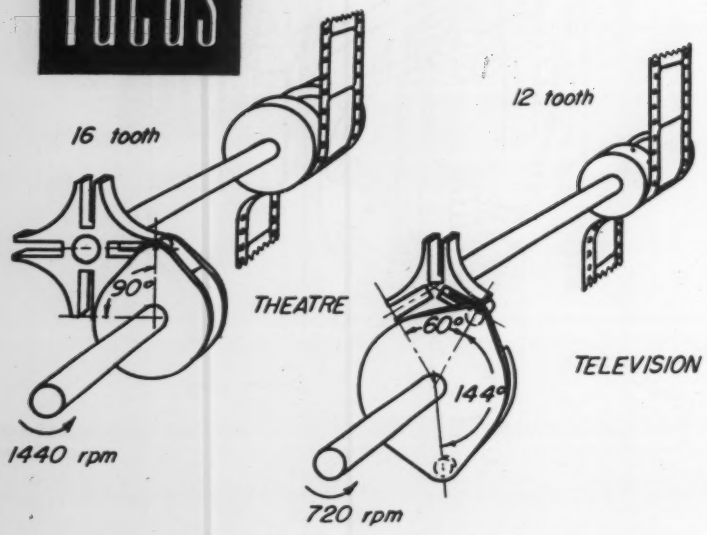
Linear speed of the chart is about 6 inches per minute. A 35-mm single-weight photographic paper without emulsion is used but has a chemical treatment to intensify the spark trace. To operate on aircraft 28-volt source of direct current, a vibrator is employed in the usual way to produce 60-cycle current for the motor as shown in the circuit diagram at right. Because of the power dissipation of the small spark coil, operation by a repetitive voltage "pip" is desirable. This pip is supplied by the inductive decay of the vibrator coil on the "break" of its main reed contact.

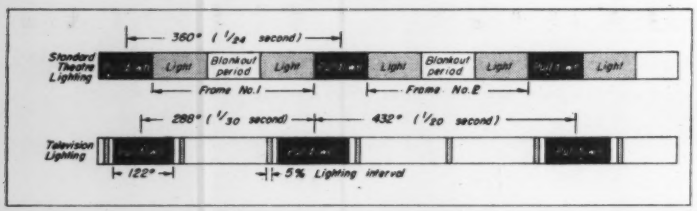


In Laboratory performance tests, the accelerometer successfully withstood shock and vibration of at least 15g units of acceleration. Paper speed was uniform to within a few per cent. Records obtained were easily interpreted and adequate for resolving detail of amplitude not less than 2 per cent of total record width.

Intermittent mechanism, having unequal time intervals, together with equally spaced lighting flashes makes possible the projection of standard 24-frame per second motion picture film on a television camera requiring a basic rate of 30 frames per second. This intermittent is a three-sided Geneva, driven by a synchronous motor and is shown schematically at top of next page compared with a standard mechanism for theater projection.

Ideas



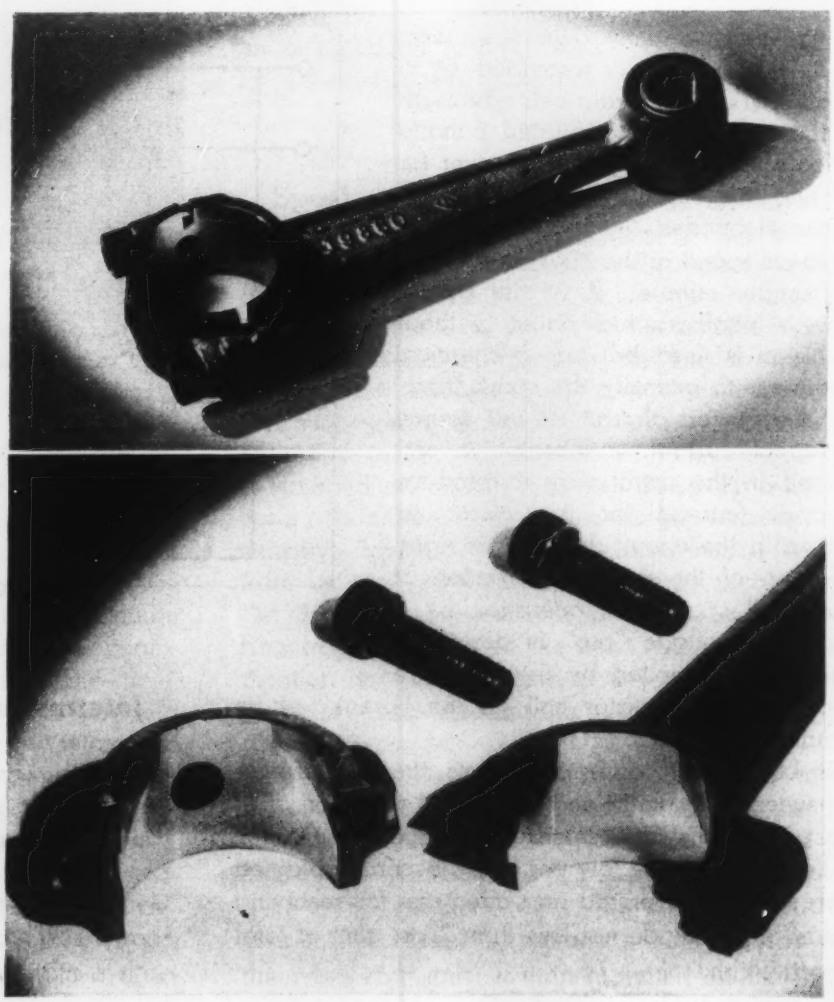


For example alternate frames remain in place in the film gate 1/10-second longer than the preceding frames. This together with speedy pulldown allows the short-duration light pulses, which flash regularly 60 times per second for 1/1200-second, to flash twice through the first frame, three times through the second, twice through the third, three times through the fourth and so on. Spacing of these light flashes is shown schematically at left compared to standard projection lighting.

Projection of film is direct upon pickup tube of the television camera, scanning in the tube being synchronized to follow the rate of the light pulses. It begins to scan immediately upon the cessation of each light flash, or during the unlighted intervals. Scanning during these unlighted intervals is possible because of the light-storage properties of the pickup tube on the television camera. The scanning is interlaced 2 to 1 so that 60 fields and 30 complete frames are scanned per second while the average speed of the film remains at 24 frames per second. Because flash lighting is used in this RCA projector, the mechanical shutter mechanism is obviated. Also adequate light is provided with negligible heating of the film or film gate, allowing projection of a single frame as a still without damaging the film.

Alignment of bearing cap without distortion is assured for the connecting rod, right, through unusual design involving a fracture at the mating surfaces. Developed by the Parks Engineering Co., the rod illustrated is 4615 steel, carburized and hardened to Rockwell C 60-62 at the large end with a 0.030-inch case after grinding. Design is such that the fracture is limited in area and is determined by general size of the rod, stock thickness around the bore and bolt size.

Distortion is eliminated through design and heat treatment to the extent that the bore will be within 0.0002-inch, TIR, after being taken apart and reassembled. This alignment feature is obtained without additional manufacturing cost. Because the mating parts are fracture-fit, there can be no slippage between the cap and rod in service when the screws have proper torque. Screws remain effectively locked without the use of locking devices because of the uniform torque applied in assembly.



Chuting and Orientation In Automatic Handling

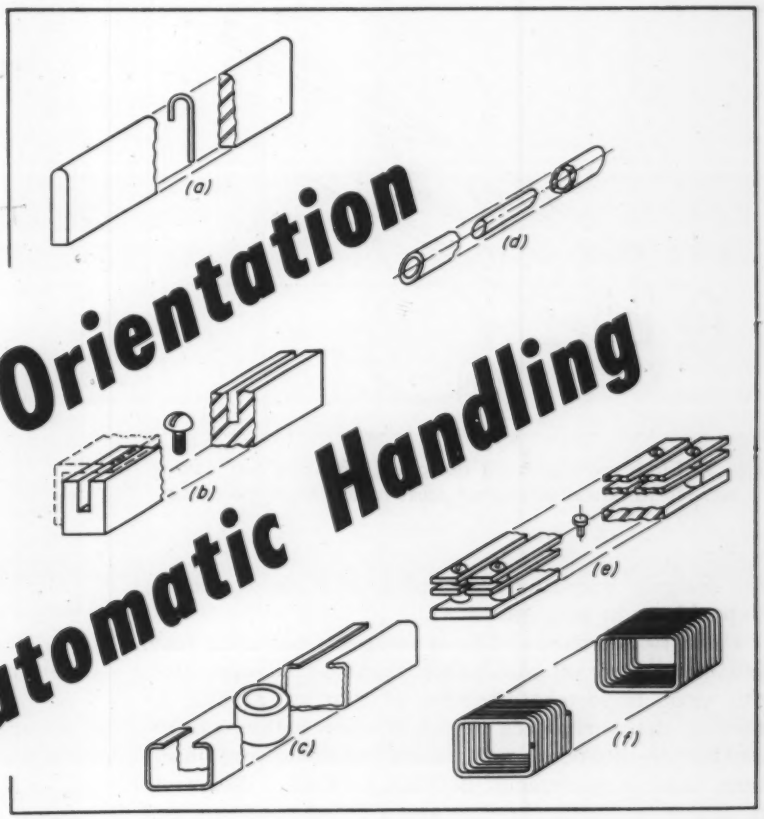


Fig. 1 — Group of sketches showing typical types of chutes and some representative workpieces

How parts are fed from hoppers and positioned for automatic assembly

By Charles E. Kraus

President
Kraus Design Inc.
Rochester, N. Y.

IN a previous article* the general problem in automatic machines of presenting workpieces in an orderly fashion was outlined and the several most common hopper feeding devices were broadly discussed. In the application of automatic parts handling equipment, the hoppering is only one of several steps leading to the final positioning of individual workpieces. Means must be provided for moving the workpieces from such devices, often providing additional orientation, many times arranging for a different direction of approach, and finally the actual transfer or positioning of the pieces into fixtures, nests, etc.

The diversity of methods or devices which are of value, and their almost unlimited modifications, make them rather difficult to present in a short article. However, there are many more or less basic methods and devices used for each of these several purposes. In the following brief discussion of a few of these,

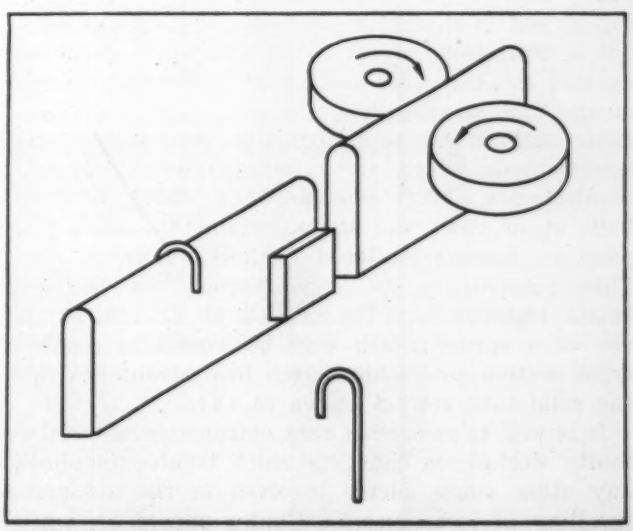


Fig. 2—Jump device for use with a chute to reject inproperly positioned pieces. Rubber friction rolls meter the pieces

*"Hopper Feeds—Basic Types and Their Design" by Charles E. Kraus, MACHINE DESIGN, Feb. 1949, Page 116.

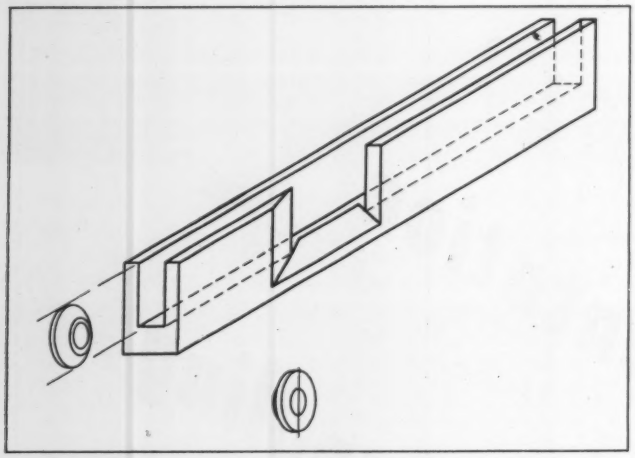


Fig. 3—Chute arrangement designed with reduced contact surface to cause unwanted parts to fall from the track

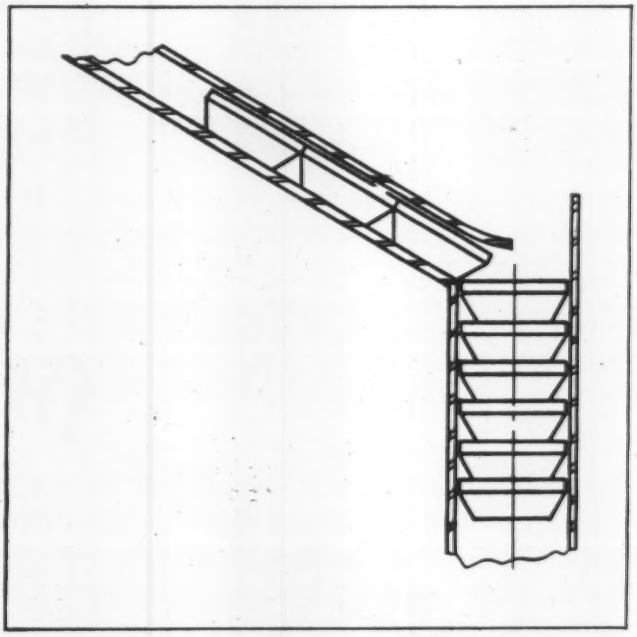


Fig. 4—Simple gravity type stacker. Height of stack must be short or speed of withdrawal uniform to obviate free falling of the workpieces

the designer may find useful ideas or leads, applicable to problems he may have.

CHUTING METHODS: The most neglected and, from the standpoint of continuous trouble-free operation, the most important problem is that of guiding or moving the workpieces in a controlled fashion. Information on hoppers, turnabouts, escapements, inserters, etc., is extremely difficult to find. But when it comes to chuting means and related problems and possibilities, the designer is almost entirely on his own. It is therefore a wise precaution to investigate the chuting possibilities of a workpiece before progressing to other phases of the handling problem. As a matter of fact, the chuting problem may define many of the related problems since, due to the nature of many workpieces, chuting may only be convenient or possible in a limited number of ways. Where this is the case, not only is the hopper affected, but also the orientation and inserting devices.

Typical Chute Sections

Shown in *Fig.* 1 is a sketch of various typical chute cross sections, together with some representative workpieces. These chutes may be a simple rail or rod as shown at (*a*), a channel with or without a restraining cover as at (*b*), a semienclosed channel as at (*c*), or a completely enclosed channel as the tube section shown at (*d*). Obviously these chute outlines can be designed or obtained by various methods which are often dictated by specific requirements. For example, (*e*) shows a chute built up of posts and strips, serving the same purpose as the semienclosed channel shown at (*b*). This construction is advantageous for building twists and curves. The section at (*f*) shows the use of a spring which may be wound to required cross section, and which often has advantages over the solid tube section shown in (*d*).

It is well to remember that extraneous material or faulty workpieces cause as much trouble as almost any other single factor involved in the automatic handling of loose pieces. Chutes should be, where possible, self-cleaning and should always be accessible throughout their length with provision for removing manually, if necessary, any obstructions. Too much attention cannot be given to this point.

Difficulty is often encountered in chuting pieces of low density, pieces having irregular shape, or pieces which, by their nature, present poor contact angles with each other, and tend to stick easily. Auxiliary devices are frequently used in such cases. These devices may be simple air jets, vibrators, or various types of positive or friction-driven feed rollers or pushers.

In addition to the type of chutes discussed in the foregoing, oftentimes it is not only advantageous but necessary to resort to conveyors, enclosed air or suction transfer means, or other more or less positive methods for moving from one position to another.

ORIENTATION PROBLEMS: Where it is not possible or practical to completely orientate the workpiece in the hopper, the designer has a great many other ways of further orientation. A method sometimes overlooked, but simple where it can be applied, is in conjunction with the chute. In *Fig.* 2 is shown the use of a jump or open spot in the chute, together with a selection device or interference, which is arranged to pass good pieces or those that are positioned as desired, and to by-pass faulty pieces or those improperly positioned. This is a very successful method, not commonly used, but capable of almost infinite variation. It can also be used as a hopper by-pass for certain types of hoppers which must have an unobstructed delivery and, in addition, its possibilities as a sorter are excellent. It is nearly always necessary to provide some sort of metering device preceding the jump section, to prevent pieces coming down too close together. This may be done in many ways. In *Fig.* 2 it is accomplished by two slowly rotating rubber friction rolls.

By reduced contact surfaces, twists or other means, it is possible to overbalance tangled, bent or faulty

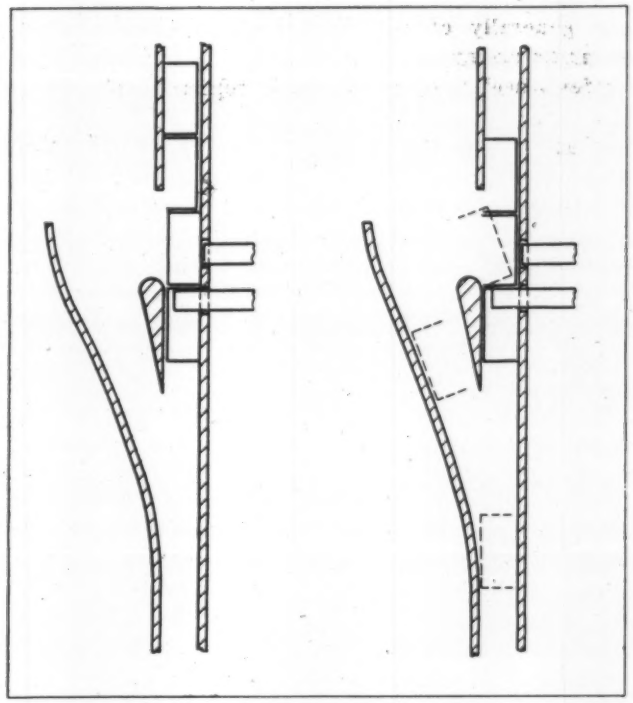


Fig. 5—An interference escapement mechanism which pushes incorrectly positioned parts over an obstruction to reverse position and re-enter the feed chute

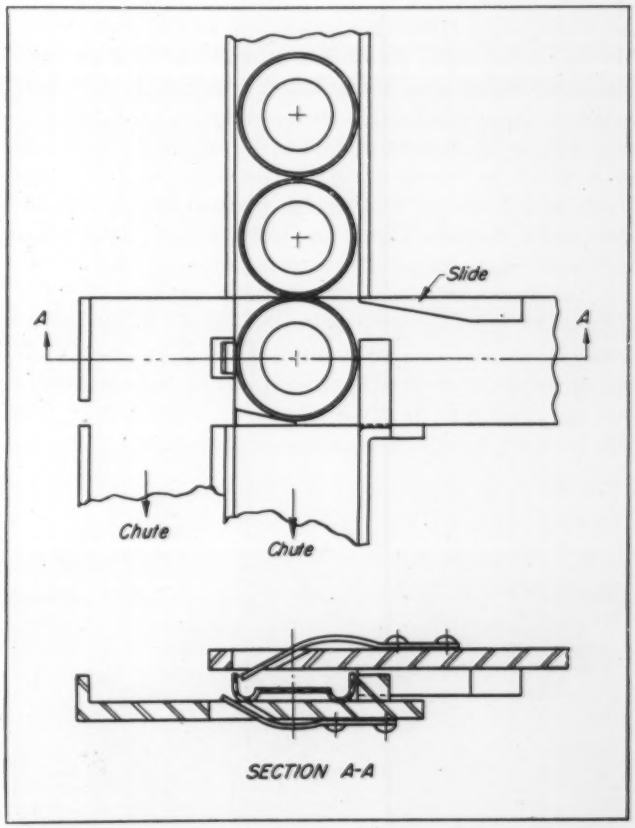
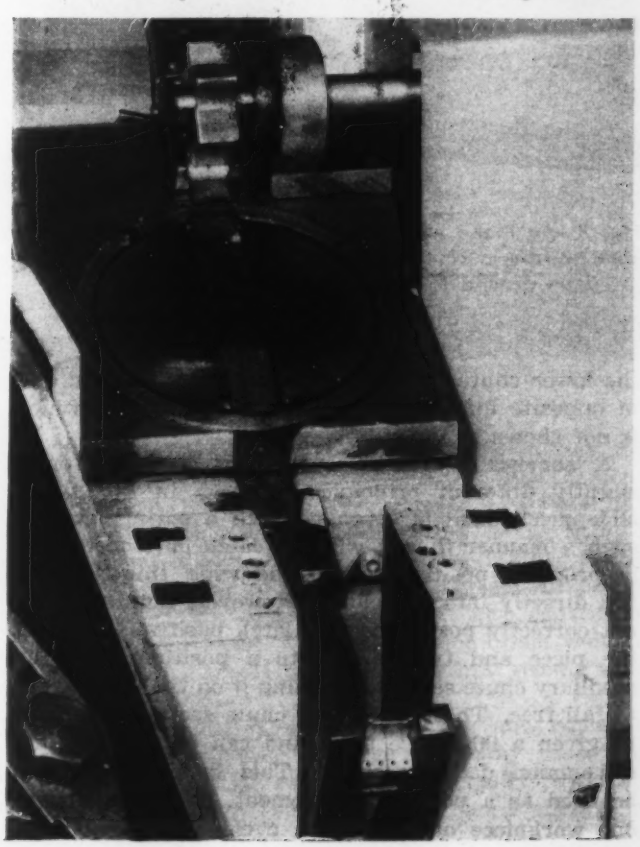


Fig. 6—Above—Positive latch escapement device which delivers one piece per cycle. Reversed parts are transferred to another chute

Fig. 7—Below—An index wheel feed mechanism which is fed by a metering wheel from an inclined chute. The index wheel directly feeds a transfer arm inserting device



pieces, *Fig.* 3. Another common method can be developed using rails or interference points, so that pieces properly positioned are allowed to move unobstructed and pieces reversed or improperly positioned are dislodged from the chute. A word of caution should be inserted at this point. Both devices shown in *Figs.* 2 and 3 rely on the action of moving pieces, and many unpredictable things can happen to such parts. Bouncing can allow unwanted pieces to miss the knock-off or may reject a high percentage of wanted parts. Occasionally such devices can be incorporated within the confines of the hopper, so that dislodged pieces will recirculate.

Altering Positions in Stacking

Another problem related to chuting and orientation arises when the hopper, for example, delivers the pieces side-by-side and it is required that they be delivered to the final positioning device end-for-end, or vice versa. *Fig.* 4 illustrates a simple gravity type stacker which can often be used to advantage. One precaution should be taken, however, in the device as shown. The height of the stacked workpieces either must be very short or the speed of withdrawing the pieces from the stack must be uniform or within the time required for the pieces to slide onto the stack from the inclined chute section. The obvious reason is that the pieces can, and frequently do, get out of position in the stack if they are given the opportunity to drop freely. Such devices can often be incorporated in the inserting mechanism or immediately adjacent, so that only a few pieces are in the altered or stacked position.

If it is not possible to obtain proper orientation of

the workpieces from the hopper by any of the methods as mentioned, there are numerous special mechanisms which can be designed specifically for this purpose. Nearly all such devices require synchronization with the inserting device or machine, and act as a valve or escapement in the line. In *Fig.* 5 is illustrated a simple and useful method which can be used with certain types of workpieces. This may be described as an interference escapement. In operation, if the workpiece is properly positioned it is allowed to move directly down the chute. If the workpiece is not correctly positioned, it interferes with the escapement device, is pushed out of the chute and can be arranged to pivot about an obstruction and fall properly orientated down a connecting "Y" to the lower chute. The two pins are moved in and out, in opposite directions, by means of a linkage which is not shown.

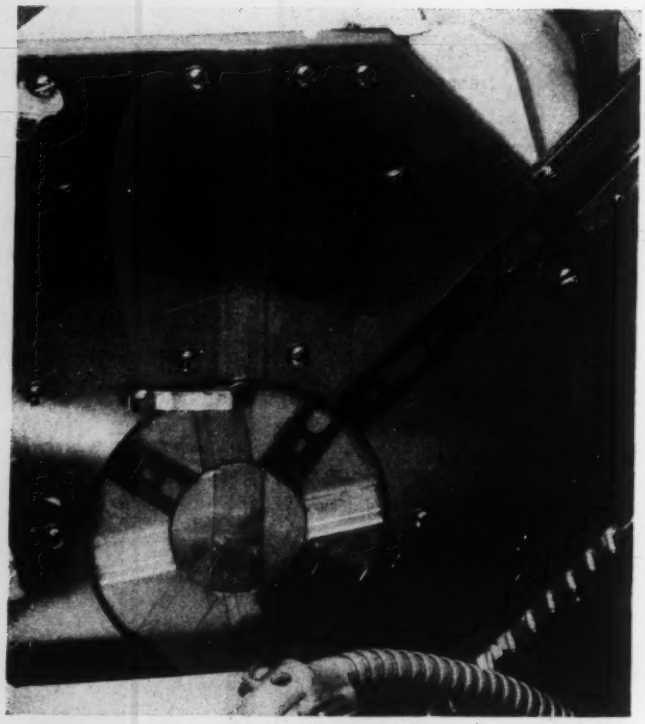


Fig. 8—An index wheel feed device which accepts parts directly from a chute. Parts not properly orientated continue around to enter the chute properly aligned

A somewhat similar mechanism operating on a slightly different principle is shown in *Fig.* 6. A slide mechanism is arranged with a spring latch in such a manner that it will not catch on a piece that is properly positioned, thus allowing this piece to fall directly into the chute. However, if the piece is not correctly positioned, the latch positively engages the piece and transfers it to a position above an auxiliary chute section, releasing it on the back stroke to fall free. These two lower chute sections can each be given a 90-degree twist and can be brought into a common delivery chute. This latter device can be used as a positive escapement, as it will deliver one workpiece only for each cycle. They are, however, generally of somewhat limited application in automatic machines.

Index-wheel type mechanisms, representative of a class of device which is very versatile in its application, are illustrated in *Figs.* 7 and 8. Workpieces obtained either directly from a chute, or metered one at a time, enter nests in the wheel which is indexed to carry the workpiece to a discharge point. Various interferences, spring grippers or spring stops can be devised to prevent the piece from leaving the wheel unless properly orientated. The piece may be allowed to fall by gravity, or it may be pushed down by a plunger.

In the latter case, some type of positive or spring-loaded stop is used which will prevent the piece moving if improperly positioned. Pieces which do not leave the wheel in this position are carried around to a bottom discharge point, which reverses their position relative to the chute into which they are allowed to fall. Devices of this nature require a certain amount of storage chute capacity inasmuch as they themselves may store one or more pieces in the wheel during normal operation.

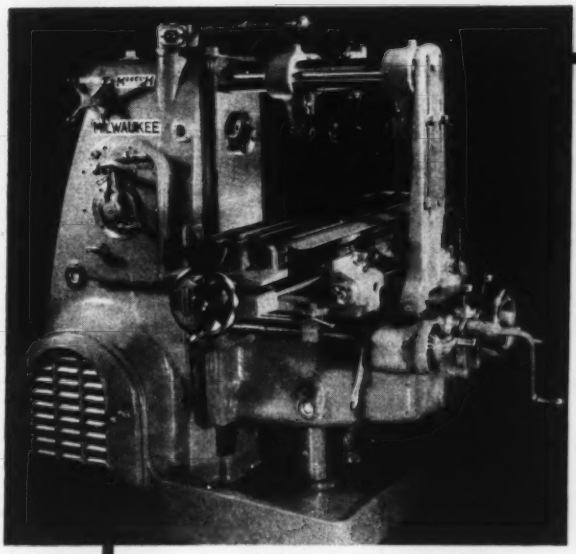
It is not always necessary that such devices index to loading or discharge positions, and they often can be made to rotate uniformly. Also, the discharge from the device may be at the nest opening, fed by the the incoming chute. This is particularly the case where the piece must be orientated in the opposite plane to those shown in *Figs.* 7 and 8. To rotate the piece in the other direction, recourse can be made to push-off devices or mechanical roll-overs, which tip the piece into an offset chute connecting to the discharge chute.

Usually, trouble is caused by extraneous matter, chips, faulty or foreign pieces, faulty adjustment of clearances, or other factors under the control of the user, but the designer must allow as much as possible for such foreseeable troubles in his designs. Under-oiling or over-oiling of mechanisms, and oil or other liquids brought in by the workpieces oftentimes cause trouble, and all of these factors must be kept in mind when developing handling equipment.

No mention has been made of any but mechanical methods in this article. The use of photo-cells, magnets, capacitors, resistors or other means to control electrical or mechanical ejectors, etc., is beyond the scope of this article, and the designer should, of course, investigate all possible means before deciding upon a specific method. However, the simple and foolproof is often overlooked. Properly developed, designed and built, all the described devices have given reliable service and show low maintenance costs.

Correction

In the article "Planetary Thread Roller Utilizes Triple Dies" (MACHINE DESIGN, July 1949, Page 130), it was erroneously stated that the production rate of the Batchelder thread roller was 750 pieces per hour. This should have been 750 per minute. Instead of being extremely slow, as indicated, this machine is actually the fastest of its type in existence.



MACHINE FINISHES

. . .what application method and what paint will best suit service

By C. L. Vandeman
The Lowe Brothers Co.
Dayton, O.

Fig. 1—Above—High gloss synthetic-base finish applied to a Kearney & Trecker milling machine

Fig. 2—Right—Laquer-base finish applied to a Cincinnati milling machine

BECAUSE an understanding of paint characteristics and a background of practical experience are valuable when specifying the paints best suited for a particular application, this article will discuss finishes and the general practice for painting industrial equipment, *Fig.* 1. Paint coatings commonly used on machines today fall roughly into three classes—oleoresinous, lacquer (pyroxylin), and synthetic-base coatings.

Oleoresinous base primers and enamels, termed "oil-base" coatings, were originally natural fossil gums with linseed oil to form the vehicle. Synthetic resins have now largely replaced the fossil gums, and linseed oil has been supplemented with other paint oils, with a net result of improved drying and better control. This type of coating dries by oxidation, sets up slowly, and requires overnight to dry. It has good brushing qualities, has good durability when designed for that purpose, and is still widely used on farm implements and many other machines, especially where brush application is preferred.

Lacquers are pyroxylin coatings. In *Fig.* 2 is illustrated the result with this finish when applied to a milling machine manufactured by the Cincinnati Milling Machine Co. Of chief interest is the type of lacquer made from nitrated cotton dissolved in suitable solvents. To this solution is added a plasticizer or softening agent, resins to provide build and better adhesion to the surface, and thinners which are nonsolvents. This gives a clear lacquer to which pigments are added to produce the desired color. Unlike oil-base finishes, lacquers dry by evaporation in as little as five or ten minutes. This fast drying feature results in a cleaner film, free from the line and dirt which settles on slower drying finishes. It also contributes to quick production. Lacquers do not brush well unless specially formulated; they give best results when sprayed or dipped.

Synthetic primers and enamels are now replacing lacquers and oil-base coatings for many uses. This discussion will be concerned principally with the glycerol phthalate type commonly called alkyd. The

air drying alkyd synthetics, as compared to oil-base coatings, are quicker setting (time required to dry dust free), adhere better, and have better gloss and color retention. They can be made highly resistant to acids and alkalis. Compared with lacquers they cannot match the speed of drying, but do have better build and gloss retention, can be made more resistant to abrasion, and are more durable under outside exposure. An example of this finish as applied to a milling machine manufactured by the Kearney & Trecker Corp., Milwaukee, is shown in *Fig.* 1.

The baking type of alkyd synthetics is the standard finish on many products like electric refrigerators and washing machines. These alkyds are usually modified with urea or other resins to shorten the bake or to give them greater resistance to fats, soaps, and alkalis. Other resins which are coming into greater use are chlorinated rubber and vinyl resins. Chlorinated rubber coatings are doing a fine job on paper mill machinery where exposure to moisture and alkalis caused early failure of other paint coatings. Vinyl resins are used chiefly in baking enamels and show good resistance to alkalis, soaps and many chemicals.

METHODS OF APPLICATION: Years ago most machines were painted by brush, except in fields where dip applications were standard procedure. Brushing was gradually replaced by spray application. The swing from brushing to spraying was speeded considerably by the introduction of lacquers and the quicker setting synthetics which are not suitable for brushing. In general, spray application saves time and labor over brush application and in most cases will produce a better looking finish.

Dip application, consisting of immersion in the tank of paint, is most practical with objects which, because of shape and design, drain freely and where the mixture in the tank can be renewed frequently. In mass production the objects are usually hung on a conveyor with hooks, or in a basket if parts are small, and the dipping is an automatic operation. Dip application does not have the wide usage of spray application because it is not practical for small scale or occasional painting. Many paint coatings lack the flowing characteristics for a good dip job, or do not have stability in an open dip tank.

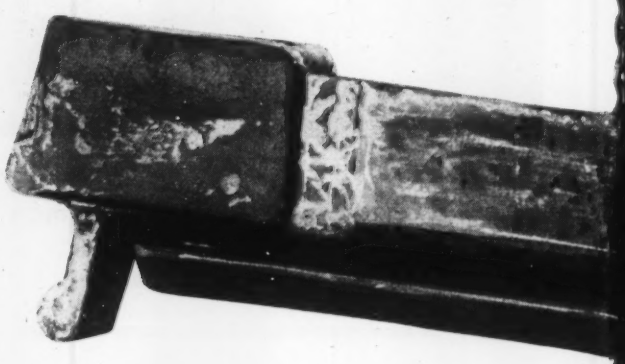
Selecting The Right Finish

Having considered the types of paint coating which are available and the importance of a suitable finish, three important questions should be raised:

1. What is the expected life of the machine and in what price class does it fall?
2. What are the conditions of service to which the machine will be exposed?
3. What type of surfaces (cast iron, sheet steel, etc.) will be finished?

LIFE OF THE MACHINE AND PRICE CLASS: An automobile requires a much better finish than a child's coaster wagon because of the wide difference in price and because the finish on a car is expected to stand up for 3 to 5 years under all kinds of weather. The finish on a bathroom scale or a metal waste basket should have sales appeal, but the finish on an electric refrigerator or an automatic washing machine must have in addition, durability under exposure to moisture, fats, hot water, and soap powder.

CONDITIONS OF SERVICE: One finish may give perfect satisfaction on interior equipment but break down in a short time on outdoor equipment. Certain parts such as boilers or airplane cylinder assemblies, operating under high temperatures, will discolor or completely break down paint coatings unless formulated for that condition. Since colors like white or light shades will discolor at continued heats of 150 F or above, most finishes for hot surfaces are limited to black, with a possibility of dark browns, greens or dark grays. Machines such as lathes, high-speed grinders, milling machines and gear hobbers have a continuous flow of cutting oils over the work and tools. Finishes for these machines must not soften or break down under these conditions. Packing and canning machinery may be exposed to fruit and vegetable juices and also to cleaning agents when the machine is washed down after the run, requiring individual treatment depending upon the severity of the juices and cleaning agents.



Surface Governs Application

TYPE OF SURFACE AND ITS PROPER TREATMENT: A machine may have several different types of surfaces, cast iron, steel plate, sheet steel, aluminum castings, and die castings. A practical finish for the complete machine must adhere firmly to each of the surfaces employed and the final effect should minimize if not completely hide the natural differences in these materials.

Cast Iron: There are many operations in transforming a rough casting as it comes from the mold into a finished machine part. *Figs.* 3, 4, and 5 show a typical casting from the time that it has been snagged and ground until it finally emerges as a part of the Harris Seybold Co. paper cutter. These illustrations make clear that a high quality finish is possible only where every step in preparation of the casting is properly carried out and a sound system of finishing is used.

It is elementary that a casting must be blasted with sand or steel grit to remove all sand from inside and outside surfaces. The next step is to snag and grind off all burrs and sharp corners, in preparation for painting. At this stage the cast surface is suscept-

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ible to rust and should be primed without delay. If castings, due to lack of inside storage, are stored outside before they are used, a primer should be selected with adequate corrosion resistance for the maximum period of storage. This will not interfere with the seasoning of the casting and will save a costly cleaning operation to remove rust.

Since the average casting is rough and full of waves even after careful grinding, one or two coats of paint cannot be expected to give the same result as on smooth sheet steel. If a smooth or "built-up" finish is required, this is done by filling all low spots with several coats of paste filler, usually applied with a broad flexible knife, and followed with a sanding operation. This should be followed with a sealer coat and one or two coats of finishing enamel or lacquer.

better practice is to use a good primer with anti-corrosive properties in place of the short-lived shop coat.

Steel Plate: Where the base or frame of the machine is welded steel plate, irregular beads of weld metal are left along the joints. If these irregularities can be removed with a portable grinder, the improved final finish is well worth the cost. An alternative is to use a fillet putty. While steel plate does not have the surface flaws of cast iron, many manufacturers use much the same finishing system to secure a first-class job.

Sheet Metal: Effective cleaning is essential to a good paint job on sheet metal. For small operations the sheet is often cleaned with painter's naphtha followed with lacquer thinner. For large operations

Fig. 3—Left—Having been sandblasted, snagged and ground, this knife-bar casting is ready for painting

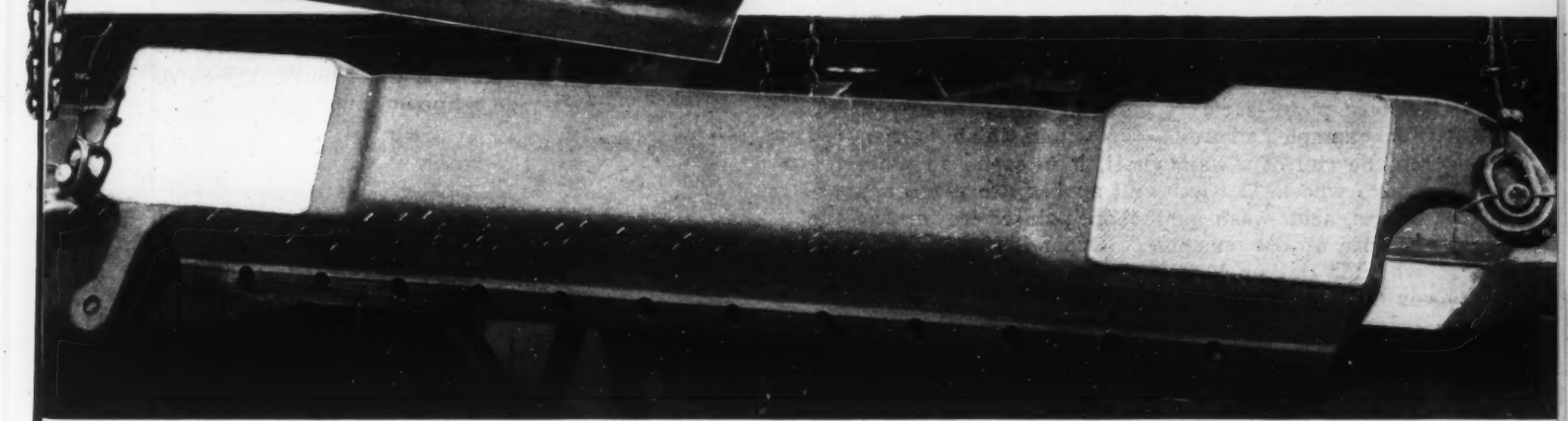


Fig. 4—Below—After priming, filling, sanding and sealing, casting is ready for assembly

Operations necessary to produce a finish of this quality are given later in this article.

Some manufacturers using small cast iron parts such as electric-motor frames are using a one-coat wrinkle finish on the housing. This requires a baking operation and is only practical where the cast iron parts can be finished prior to assembly and are not liable to damage in completing the machine.

Massive machines such as hydraulic presses are usually primed and given a coat of enamel without any attempt to disguise the rough cast surface. In such cases an eggshell gloss enamel gives a better appearance than a full gloss enamel. Many types of equipment are given a "shop coat" to be followed with a finish coat after erection. Too often these shop coats are chosen for speed of drying and low price per gallon. They not only fail to protect the casting during shipment and storage but are much too brittle to effectively serve as a primer under the finish coat to be applied after installation. A much

Bonderizing (Parker Rust Proofing Co., Detroit) is effective. Many plants have three or five-stage cleaning operations such as those set up by Oakite Products Inc., New York City or Wyandotte Chemicals Corp., Wyandotte, Michigan. The three-stage system usually consists of three adjacent tanks with a hot alkali solution in the first, a clear water rinse in the second and chromic rinse in the third.

In the case of terne plate or smooth cold-rolled steel, a phosphoric acid wash following the ordinary cleaning operation is recommended to etch the surface and improve adhesion of the paint coating. The Neilson Chemical Co., Detroit has developed this treatment.

Sheet metal parts such as guards and hoods should have a good alkyd synthetic primer followed with the standard finish coat used on the balance of the machine. Heavier gage sheet is used together with cast steel on many types of farm machinery. In this field, however, a single coat of enamel is the general rule

in which case it should be a weather resisting oil-base enamel or synthetic enamel. Manufacturers of electric controls and switchboard prefer a baked synthetic enamel for its durability and resistance to mars and scratches.

Hammered finishes and similar novelty effects offer the advantage of hiding scratches and roll marks in the sheet sheel. In the air-drying quality, these finishes are short-lived and practical only on inexpensive gadgets. The same finish in a baking quality has proved practical and serviceable on automobile heaters and vacuum sweepers, for example. Wrinkle finishes are also used on many similar products.

Aluminum Castings: Paint coatings do not readily adhere to aluminum castings. A treatment with "Metalprep" (Neilson Chemical Co.) or some other phosphoric acid wash will go far to correct this shortcoming. An alkyd synthetic-base primer will also have better adhesion than an oil-base or lacquer base primer. Like cast iron, aluminum castings require filling and sanding for a built-up surface. Because of minute blow holes the filling operation offers problems, however, not met in cast iron surfaces.

Die Castings: As with aluminum castings, paint coatings do not have good adhesion to die castings without special treatment. A high bake finish is recommended wherever possible. If air drying coatings must be used, a phosphoric acid wash or similar treatment to etch the surface is a "must" to insure a good bond between primer and metal.

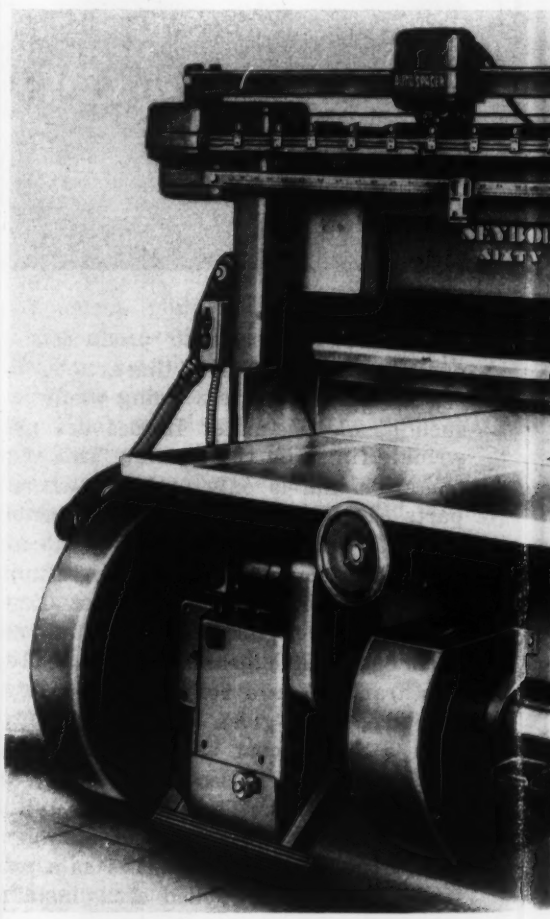
Chromium Plated and Ground Surfaces: While chrome plate is rarely painted, there are exceptions. For example, where a chromium finish is required on the rim of a handwheel, it is easier to plate the entire wheel. The hub and spokes are given a phosphoric acid wash and then painted to match the balance of the machine. Ground rims of pulleys, whether flat or V-shaped, are usually given a clear or transparent blue coating to guard against rust in transit and storage. Recommended finish is a synthetic-resin modified lacquer.

Detailed Finishing Systems

Following is the outline of a complete built-up finishing system which, with minor variations, is standard with the majority of machine tool builders. The system involves alkyd synthetic primers, a choice of synthetic or lacquer-base fillers, and lacquer-base top coats. Synthetic-base primer has shown definite superiority over oil-base or lacquer-base primers for adhesion to cast iron, cast aluminum, steel plate, and sheet steel. The system produces an eggshell or semigloss topcoat which is standard. *Fig.* 6, an American Machine and Foundry Co. mixer and *Fig.* 7, a Miehle Printing Press & Mfg. Co. printing press illustrate the result obtained when this finish is used.

Cast Iron Surfaces

1. *Preparation of Surface*: All castings should be blasted with sand or steel grit to remove all trace of sand from interior and exterior surfaces. All burrs, fins and humps should be removed by chisel or portable grinders
2. *Priming*: Spray with one coat of synthetic primer light gray. For sealing interior of gear cases, spray with one coat of pyroxylin gear-case sealer. This sealer must have good adhesion to the bare casting and withstand constant immersion in lube oil at working temperatures. The popular colors are red oxide, ivory, yellow, or white
3. *Filling Major Castings*: Use pyroxylin filler light gray or synthetic filler light gray. Use in full body and spot glaze all deep flaws and cavities in casting. Next, reduce filler slightly with recommended thinner and glaze two or three successive coats over entire cast surface using flexible glazing knife and rubber pad. When dry, rough sand with No. 100 production sandpaper, and finish sand with 120 or 150 grade
4. *Filling Small Castings*: Reduce filler as recommended and spray two coats, allowing thinner to flash out between coats. When dry, sand with No. 120 production sandpaper. Prominent parts such as levers may need a complete sanding but many of these small castings require only a scuff sanding
5. *Sealing the Filler*: Spray one double coat of pyroxylin sealer light gray. Machining and assembly usually follow this stage in the finishing schedule
6. *Cleaning* (after assembly and tests): Clean entire surface with brush dipped in mineral spirits and lacquer thinner (mixed about equal parts). Wipe dry with clean rags
7. *Patching and Masking*: Spot glaze all damaged spots with Non-Shrink pyroxylin putty. This putty will dry while the machine is being masked. Mask all plated and polished surfaces (not to be painted) with paper shields and masking tape. After machine is completely masked, sand the putty and blow off dust



8. *Sealing*: Spray one full coat of pyroxylin sealer light gray. This seals the patched surface and insures a uniform background for the finish coats
9. *Finish Coats*: Spray two successive coats of 7-B standard machine tool gray lacquer
10. *Clean Up*: Remove masking shields and tape. Attach name plates and send to shipping room.

SHEET METAL PARTS

1. *Preparation of Surface*: All metal must be free from rust, mill scale, grease and dirt
2. *Priming*: Spray coat of synthetic primer light gray
3. *Finish Coat*: Spray one or two coats of 7-B standard machine tool gray lacquer.

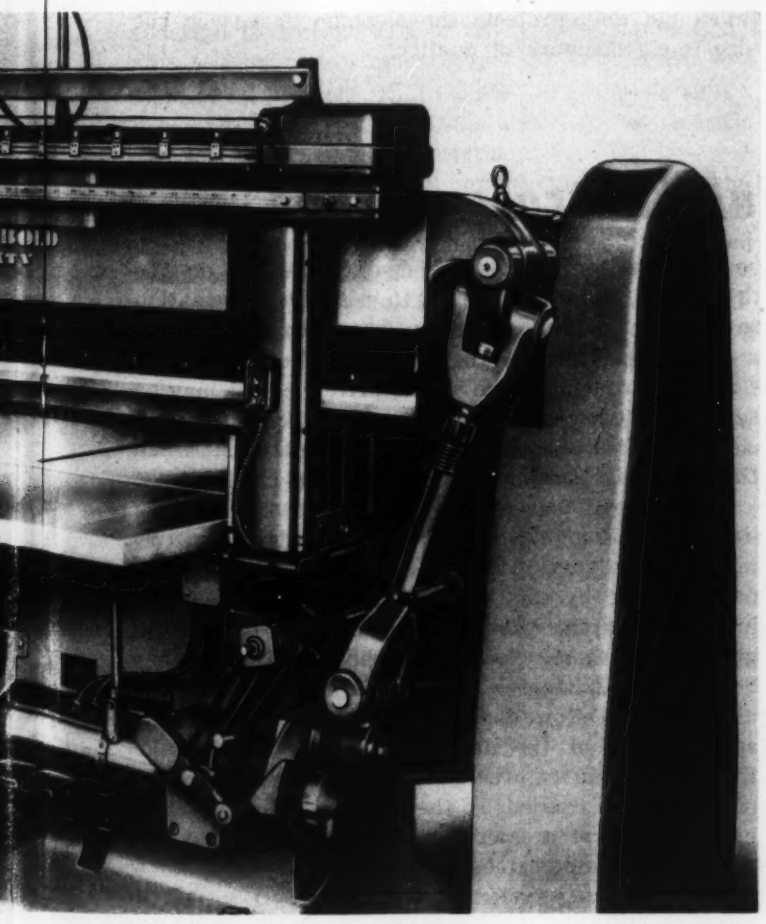
Where the price of the machine will not justify a built-up finish, a pebble finish may be used at a much lower cost. In April, 1942 the War Production Board issued their limitation order prohibiting the filling operation on machine tools in an effort to speed up production. The resulting finish was such a "let down" from their previous standard that many manufacturers adopted a pebble finish as a means of camouflaging the roughness of the casting. Due to the restriction to one finish coat over the pebble coat, the resulting job was rough and harsh, making it difficult to wipe off sludge and grease. Freed from war restrictions the pebble finish has now been greatly improved so as to permit easy cleaning of the machine, and still shows a marked saving over the smooth finish. Following is an outline of operations for producing a pebble finish on cast iron.

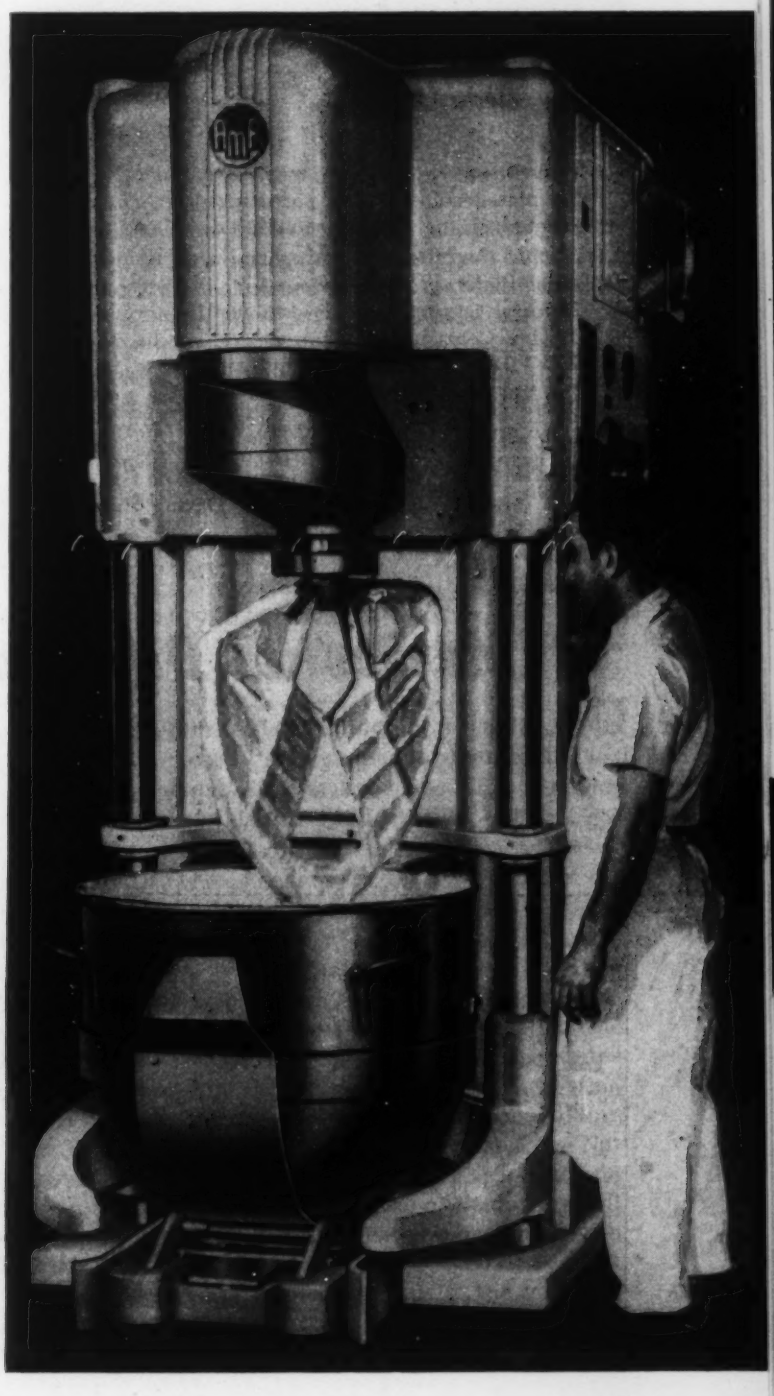
PEBBLE FINISH FOR CAST IRON SURFACES

1. *Priming*: Spray one coat of synthetic primer light gray. At this stage in the finishing schedule castings should be sent through machining and assembling operations
2. *Cleaning* (after assembly): Clean entire machine with brush dipped in mineral spirits and lacquer thinner (mixed about equal parts). Wipe dry with clean rags
3. *Patching and Masking*: Touch up with brush any bare spots due to grinding and fitting, or to damage in primer coat, using pyroxylin sealer light gray. Patch any bad cavities in casting with

Fig. 5—Below—Knife-bar casting assembled with other parts into a Seybold paper cutter and painting completed

Fig. 6—Right—Glen mixer illustrates what a complete built-up finish can add to appearance





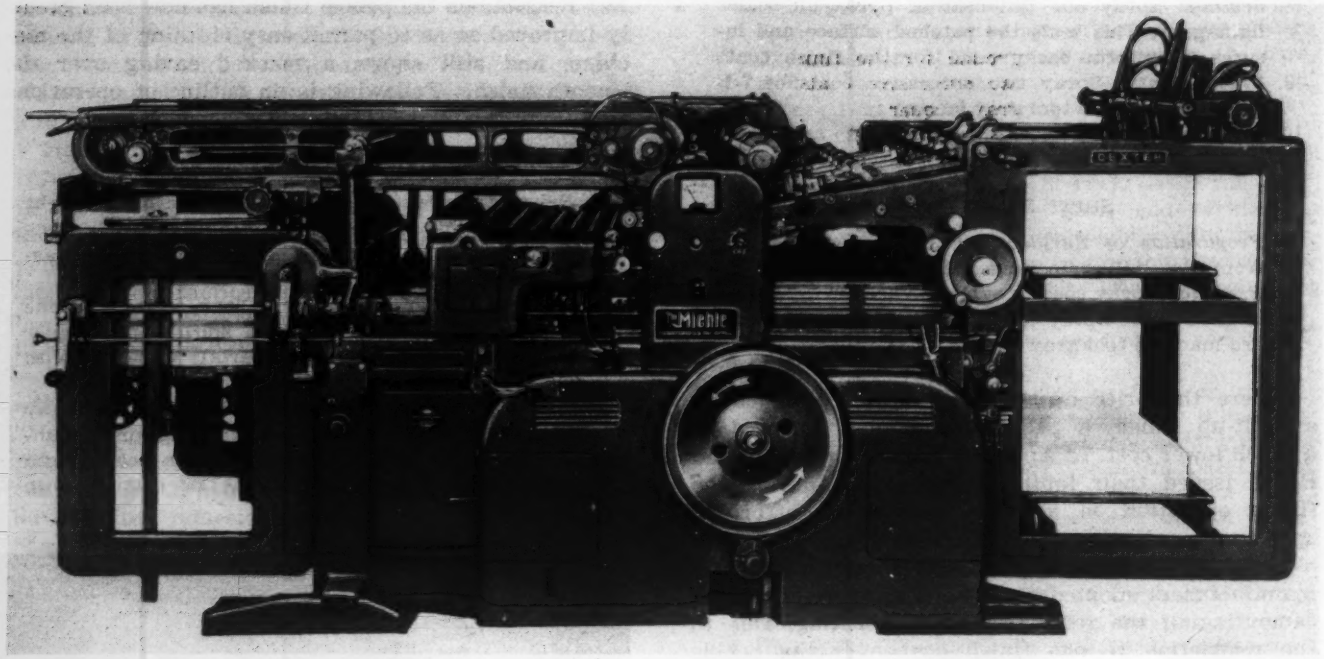


Fig. 7—Design is enhanced by complete built-up finish as evidenced by its application to a Miehle printing press

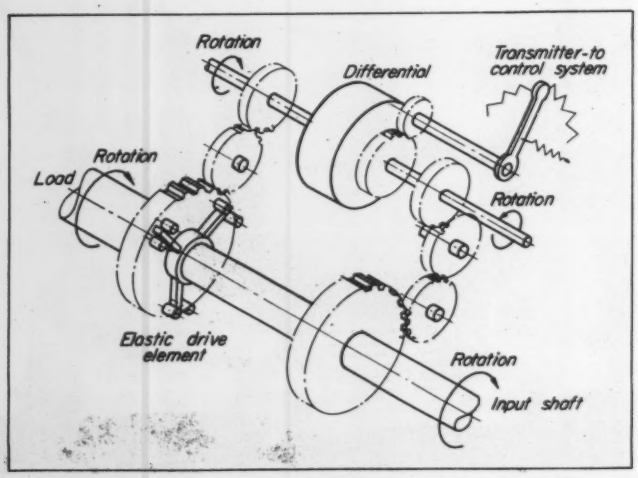
Non-Shrink pyroxylin putty. No sanding. Mask all plated and polished parts which should not be painted, using paper shields and masking tape

4. *Pebble Coat*: Spray one spatter coat of pyroxylin filler light gray, reduced 3 to 1 with lacquer thinner. Drying time is 1 hour. In applying the Pebble Coat, use 765 cap and E needle with the MBC DeVilbiss gun, or equivalent. Use 15 to 20 psi pressure on material bucket, and a maximum of 15 to 20 psi atomizing pressure. Adjust spray gun for the spatter action.
5. *Finish Coats*: Spray one double coat of 7-B standard machine tool gray lacquer. Drying time is 15 minutes. Then spray one double coat of clear lacquer. Drying time is 15 to 30 minutes
6. *Clean Up*: Remove masking shields and tape. Attach nameplates.

The subject of finishing is important. An attractive and well chosen finish will make favorable first impressions. A durable, easily cleaned, and attractive finish not only protects the machine in service but also is a trademark of quality.

Mechanical Differential Controls Torque

UTILIZING a mechanical differential, torque control illustrated offers a high degree of accuracy combined with compactness and simplicity. In addition to the differential, two other elements are required—a torque-sensitive device mounted on the drive shaft, and a transmitter to relay the information to a torque-regulating system. The illustration shows a design developed by the Milwaukee Lock and Mfg. Co. The torque-sensitive elastic drive element may be seen at the lower left-hand corner, and consists of slender radial beams or leaf springs through which the power is transmitted between line shafts.



As the load increases, angular deflection of this drive element increases in direct proportion, the two main pick-up gears as well as the power shafts being out of phase by this same angle. Mounted with its inputs across the two pick-up gears, the differential gives as its output a measure of the angular difference between the driving and the driven shafts. Since this angular deflection depends upon the stiffness, or spring scale, of the deflection system and on the torque transmitted, the output is a direct measure of the torque carried by the system. This output is used to control a transmitting device, such as the potentiometer indicated, which sends the data to a torque-regulating system.

How Codes Affect

Pressure Vessel Design

By Neil Osborn
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Struthers Wells Corporation
Titusville, Pa.

PRIOR to the actual fabrication of an unfired pressure vessel, it is practically mandatory that the design be checked and approved by the authority under whose jurisdiction the use of the completed vessel will fall. Various Federal, State, and municipal rules have been formulated stipulating maximum and minimum requirements which must be met before a completed vessel may be put into service in a particular locality. Such governing regulations or codes fundamentally preclude any procedure which violates safety principles. It is the purchaser's right to be fully assured that his investment will embody design principles of such a proved nature that any risk to personnel, as well as property, will have been reduced to a minimum. Consequently, when evaluating a design, the engineer must consider and apply every measure of precaution at his command.

Aside from the standpoint of safety, insurance coverage obtainable is of direct concern. Design and construction meeting the intent of the existing codes, either singularly or in a combination, invariably comply with qualifications established by the various liability underwriters, with the result that the finished product is theoretically sound as far as our present-day knowledge is concerned, and unquestionably safe.

To elaborate upon the design features of any one particular code is beyond the scope of this article. However, the requirements of the various agencies, including those responsible for codes, will be reviewed and discussed.

ASME Code Restricts Design

Outstanding today as a criterion upon which to base a design is Section VIII of the ASME[1] Boiler Code. This section covers essentially unfired pressure vessels for use in the 15 to 3000 psi pressure range. Three paragraphs, U-68, U-69, and U-70, are specific restrictions on vessel construction.

Briefly, paragraph U-68 construction must be employed whenever the operating pressure exceeds 600 psi. An additional requirement is that the completed vessel must be subjected to a heat-treating process to remove all internal stresses. Further, all longitudinal and circumferential weld seams are to be radiographed by either the X-ray or gamma-ray method.

Paragraph U-69 covers vessels for use at operating pressures between 200 and 600 psi with plate thickness at a joint limited to 1½-in. maximum. Although radiographic examination of the seams is not required for vessels constructed in accordance with this paragraph, heat treatment of the completed vessel is necessary under certain conditions.

Construction complying with paragraph U-70 requires neither radiographic examination nor heat-treatment, but restricts construction to pressures below 200 psi and temperatures not exceeding 250 F.

Vessels fabricated in conformity with the foregoing and complementary paragraphs are subject to inspection by an authorized inspector and must bear the official code symbol.

To illustrate the problem of placing a pressure vessel into actual field operation, consider an unfired cylindrical pressure vessel designed to operate at 3000 psi and constructed of a material[2] acceptable to the code. The first step is to obtain design approval from the insurance company representing the purchaser. This is ordinarily handled by the submittal of design details of the pressure components only, together with a set of substantiating calculations. Upon receipt of this approval a serial number, acceptable to all parties concerned, is assigned to the design and it is ready to be released for fabrication.

The foregoing example is based on the assumption that the vessel will be installed in a locality where the National Board exercises no power, with the result that the particular state or municipality has definite jurisdiction and may request further approval. It should be pointed out that the National Board of Boiler and Pressure Vessel Inspection[3] is composed of chief inspectors of states and municipalities in the United States and of provinces in Canada that have adopted the Boiler Code; the function of this Board is to administer and enforce the rules of this code. Certain states and provinces have no record of having in effect the boiler laws. Similarly, several of the states where such laws are in effect do not insist upon special stamping and inspection of unfired pressure vessels. Should the vessel be constructed for use in one of the states recognizing the existing boiler laws, then inspection must be made by an authorized inspector holding a National Board commission. In this respect a National Board (NB) register number is assigned and this, in addition to the insurance company's serial number, is stamped on the vessel nameplate with the code symbol.

Meanwhile, special forms required by the code are executed by the manufacturer, and properly signed and transmitted to proper parties, thus certifying

[1] References are tabulated at end of article.

that the vessel is now satisfactory for use under the purposes originally intended.

The site of installation is of pronounced importance as evidenced from the fact that should the vessel as described above be intended for use in the state of Ohio it could not be considered a strictly code-fabricated product, for the reason that the working pressure exceeds 2500 psi, which is the maximum permitted by the present Ohio code. Thus, special approval would have to be obtained from the Industrial Commission of that state and a special number assigned.

Choice of materials and operating conditions are factors affecting basic design. Likewise, special alloys and metals for use at sub-zero and elevated temperatures require special investigation. Where material employed is other than that accepted by the code, the construction is considered non-code and special approval must be secured from the insurance authority. Such vessels, in turn, cannot bear the NB register number.

Vessels Outside ASME Code

There are certain exceptions where vessels constructed in accordance with Section VIII do not require official inspection but may be inspected if the customer so insists. These exceptions embrace vessels of 5 cubic feet capacity or less, designed for pressures not exceeding 250 psi and those vessels having a capacity of 1½ cubic feet or less at design pressures exceeding 250 psi. These cannot bear the code symbol, but may carry an insurance company's serial number obtained by special approval.

In addition to the foregoing, there are certain classes of vessels definitely outside the jurisdiction of this section of the code, which may not be fabricated according to the code rules. Such restrictions follow:

1. Vessels subject to Federal control
2. Locomotives, all types
3. Vessels for flammable liquids and gases at temperatures exceeding 300 F
4. Vessels subject to collapsing pressures of 15 psi or less
5. Vessels having an external or internal pressure of 15 psi or less, irrespective of size
6. Vessels having an internal diameter of 6 inches or less, irrespective of pressure.

In the event the pressure vessel is for use in the petroleum industry, it must conform to the requirements of the API-ASME Code, jointly adopted by the American Petroleum Institute and the American Society of Mechanical Engineers. It should be recognized that there are likewise rigid limitations of this particular code which will not be discussed at this time. Inspection in API-ASME work is handled somewhat differently than regular ASME procedure. No register or insurance company serial number is required and all inspection, aside from the manufacturer's usual practice, is generally conducted by some outside organization in no way connected with the vessel fabricator. After complete approval by the designated inspection agency, the official API-ASME Code symbol is affixed to the vessel nameplate and the necessary forms executed in accordance with the provisions of this code.

Vessels constructed for use in the provinces of Canada must have the complete approval of the Department of Labor of the province wherein the unit is to operate. A Canadian Standard (CESA) number is assigned by the province and special affidavits are prepared and notarized, allowing its use.

Vessels constructed for operation in a foreign country may sometimes require special analysis regarding inspection, but generally speaking, most code-fabricated equipment bearing a United States liability underwriter's register number and an NB number is sufficient.

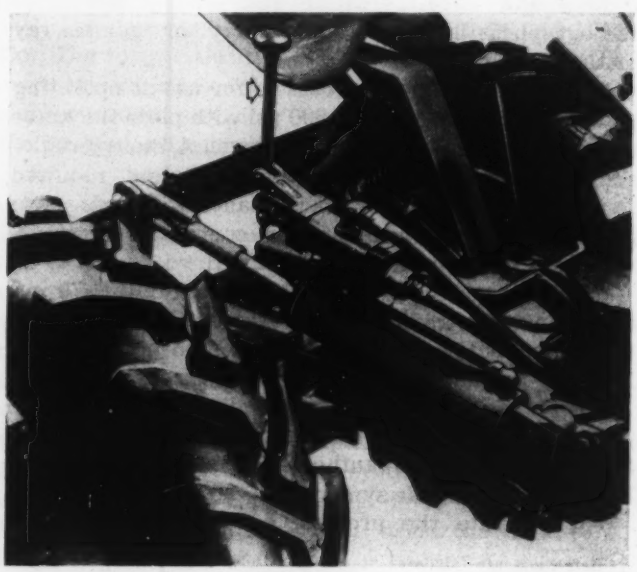
Even this general treatment reveals the fact that there is a close association between the actual fabrication and the inspection of pressure vessels. This article is not offered as an authoritative analysis but was written with the desire to clarify to some degree the procedure of inspection and to emphasize the necessity of exhaustive study of codes which govern fabrication.

REFERENCES

1. *ASME Boiler Construction Code*, American Society of Mechanical Engineers, 29 West 39 St., New York, N. Y.
2. "Material Specifications," Section II *ASME Boiler Construction Code*.
3. *Synopsis of Boiler Laws, Rules and Regulations*, National Bureau of Casualty and Surety Underwriters, 60 John St., New York 7, N. Y.

Hydraulic Control Valve

AN AUTOMATICALLY centering valve that locks an operating piston in any position is used to control movement of the various accessories of the Leader tractor. When the operator's hand is removed from the control lever, the valve automatically centers. This action locks the piston in any selected position in its cylinder, holds the tool up or down or at any intermediate point, and at the same time relieves pump pressure directly to the supply tank through the "open center" feature of the valve. An integral relief valve is factory set at 800 psi for over-pressure protection during the operating cycle. The control valve is made by the Romec Pump Co. Division of Lear Inc.



Their Influence On Design

By Roger W. Bolz
Associate Editor, Machine Design

Part XLVI–Centrifugal Casting

OBSCURE among the methods of casting metals, the centrifugal processes in recent years have made considerable progress. Though a routine production technique for more than a quarter of a century, centrifugal casting as a modern process has evolved largely in the last six or eight years owing to design requirements. Seeking both improved production possibilities as well as lower cost means for manufacture of unusual machine parts resulted in recourse to centrifugal methods of casting to gain the obvious advantages of the static casting process as well as to eliminate its shortcomings.

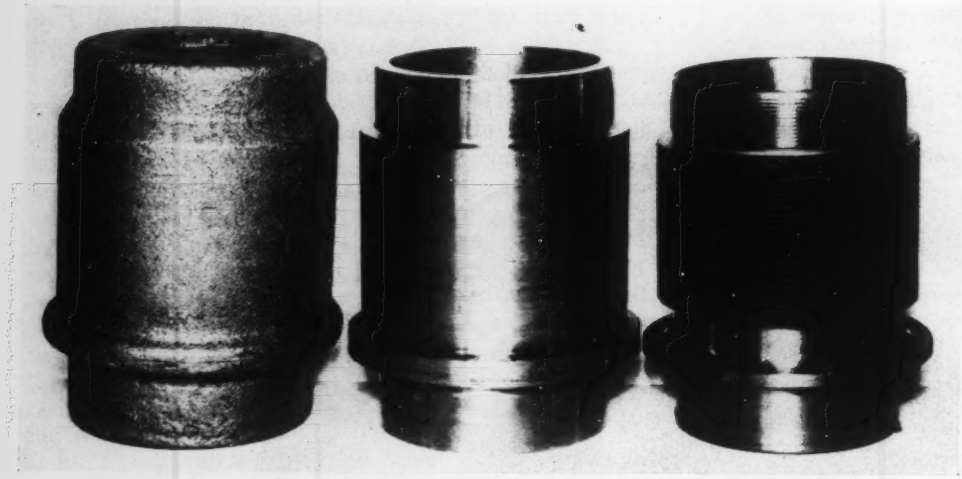


Fig. 1 — Left — Chromium-molybdenum alloy steel radial engine cylinder barrel casting shown as centrifugally cast, rough machined and finished

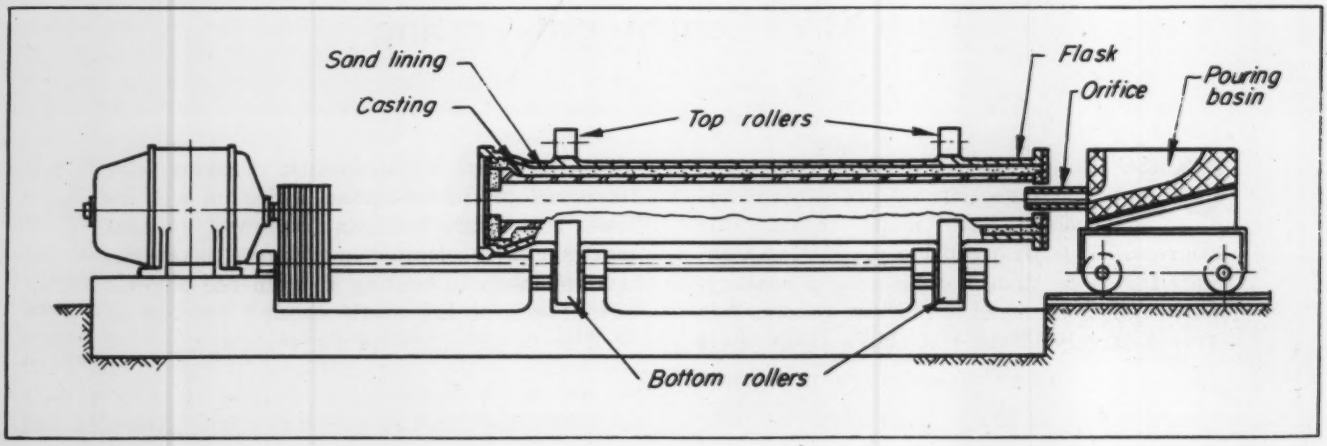
CENTRIFUGAL CASTING METHOD: As can be surmised, feeding of the molten metal in centrifugal casting is achieved through centrifugal force produced with a revolving mold. Thus, in effect, it is basically a pressure casting method as against static casting which is carried out at atmospheric pressure with the height of the gates and risers providing the only means of pressure. Generally, impurities such as dirt, sand and slag, owing to lower specific gravity, are forced to the inside surface of the spinning mold by differential force along with any gas or air pockets. Elimination of these inclusions results in a more sound cast metal with uniform strength throughout, greater density, and decidedly better physical properties. For this reason, the process has found wide usage for pressuretight parts, *Fig.* 1. Physical properties for the most part compare favorably with those of forgings and in many cases permit the economical production of parts from metals which are extremely difficult or impossible to forge. In addition, the method permits the satisfactory production of unusual designs not economical by static casting methods.

TRUE CENTRIFUGAL CASTING: Best known and simplest of the centrifugal techniques is generally referred to as true centrifugal casting. In this method the mold is spun about its own axis and the inside of the casting is formed by centrifugal force acting on the metal, *Fig.* 2. No core is required and the interior cavity becomes a true cylinder, regardless of the exterior shape, whose diameter is determined by the volume of metal. The external surface need not be cylindrical in shape and may be modified by flanges, bands, flutes, or projections; the major requirement is that the shape be symmetrical about its central axis to avoid unbalance, *Fig.* 3.

With this method molds may be rotated about their own axes either in a horizontal or a vertical position. The inner surface with horizontal rotation always becomes a true cylinder but in vertical rotation the force of gravity becomes effective and a paraboloid form may be produced. Where length is moderate, however, this effect is only minor but, because of the excessive speed which would be required to force metal to rise along the mold walls evenly where taper is undesirable, part length can seldom exceed twice the diameter.

In general, horizontal-axis casting is chosen where part length exceeds the diameter. It is well adapted for the manufacture of short and long tubular parts such as pipe, tubing, cylinder barrels, hollow drive shafting, sleeves, bearings, liners, rolls, shells, etc. Outside diameters of parts which can normally be

Fig. 2—Below—Horizontal type true centrifugal casting machine for long parts. Sand lining is inserted by packing around a short plug which is raised progressively



produced range from approximately 2 inches to 50 inches in lengths up to 347 inches, maximum. The largest true centrifugal casting poured to date required a charge of 58,935 pounds of metal and measured 54¾ OD by 48⅞ ID by 342 inches long (54⅛ by 51 by 302 inches finished). The maximum wall thickness poured normally may range up to about 5 inches.

With vertical-axis casting, parts which have diameters exceeding their length are the usual production. Diameters may range up to approximately 6 feet and length generally to several feet.

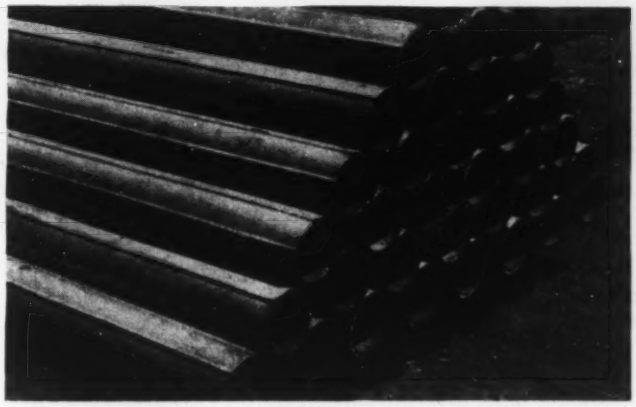


Fig. 3 — Above — Fluted tubes centrifugally cast into 16-foot lengths for use in making electric motor stators. As-cast tube is 4¾-inch in diameter and has a bore of 4-1/16 inches. The OD tolerance is ±0.015-inch while that for the ID is ±0.08-inch

SEMICENTRIFUGAL CASTING: Almost identical to true centrifugal casting, the term semicentrifugal is applied to the process where cores are employed to modify the casting or bore produced. The vertical method is always used and stepped bores, noncylindrical bores or other cored features of a wide variety of designs can be had with good production, *Fig.* 4. As can be readily seen, parts with small-diameter bores may have metal at the bore which is not as good as that at the periphery. Where bores are sufficiently large, superior castings can be produced which are extremely difficult or impossible to make by other methods, *Fig.* 5.

CENTRIFUGE CASTING: In reality a method of pressure casting, the vertical centrifugal casting process is also used to produce nonsymmetrical castings which cannot be rotated about their own centerline. Centrifugal force by this method is utilized to aid in forcing molten metal to fill a group of molds arranged in a single layer, or in groups of molds located about a central sprue in multiple layers, *Fig.* 6.

The problems involved with centrifuged castings

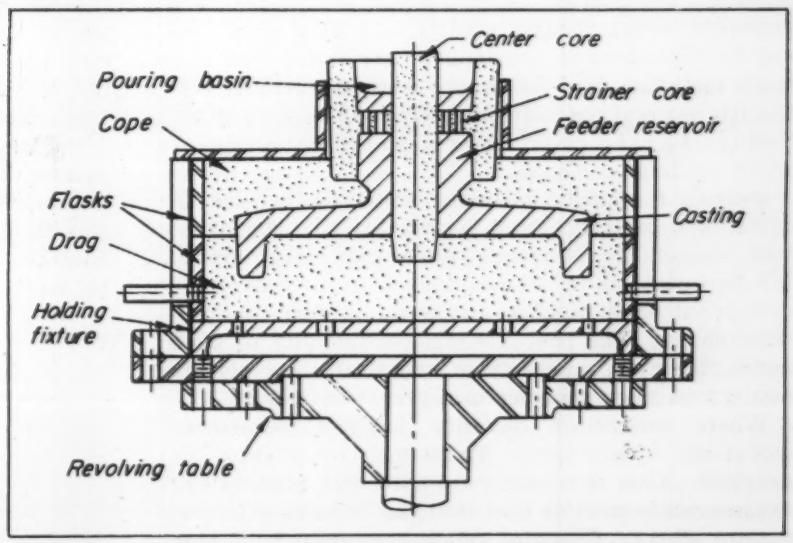
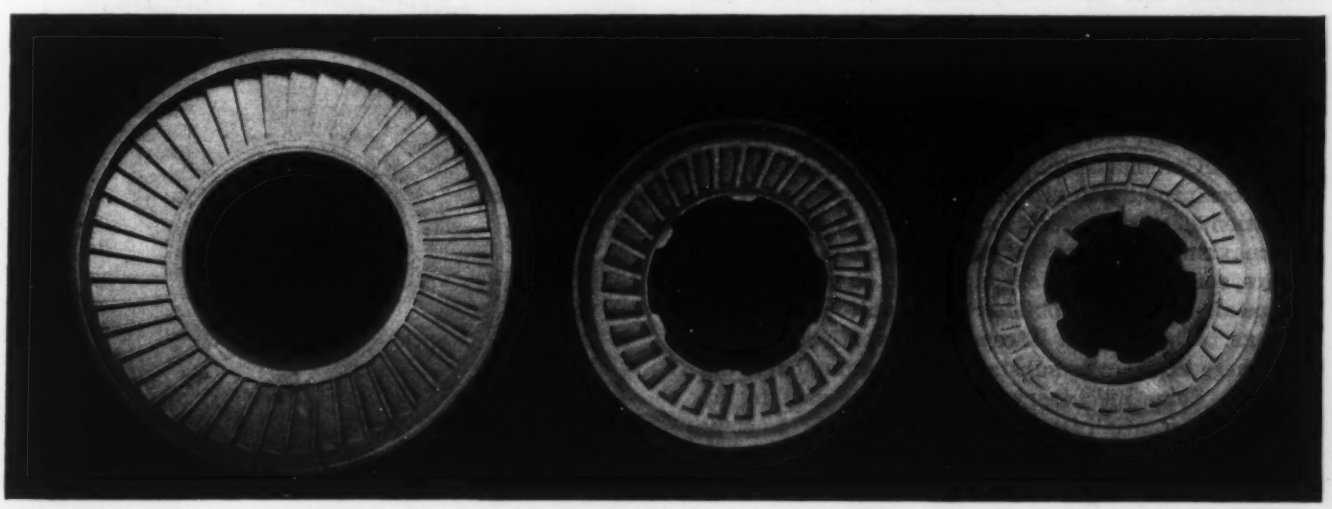


Fig. 4—Right—Semicentrifugal casting setup for producing a cored flywheel

Fig. 5—Below—Group of turbo-supercharger diaphragms produced by the semicentrifugal method in dry sand cores



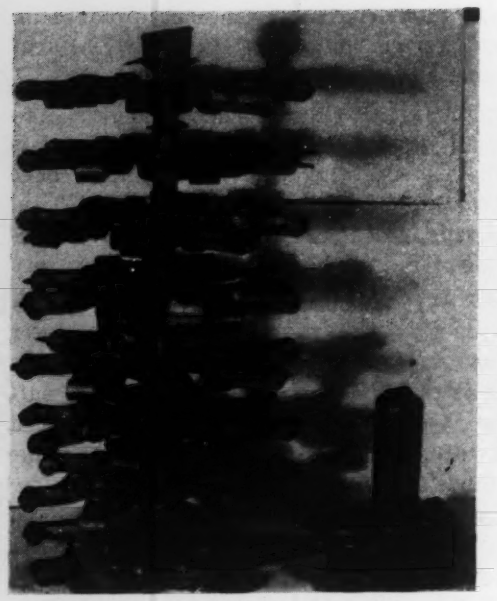


Fig. 6—Above—Bracket castings produced by centrifuging both in a single layer and in multiple layer arrangement

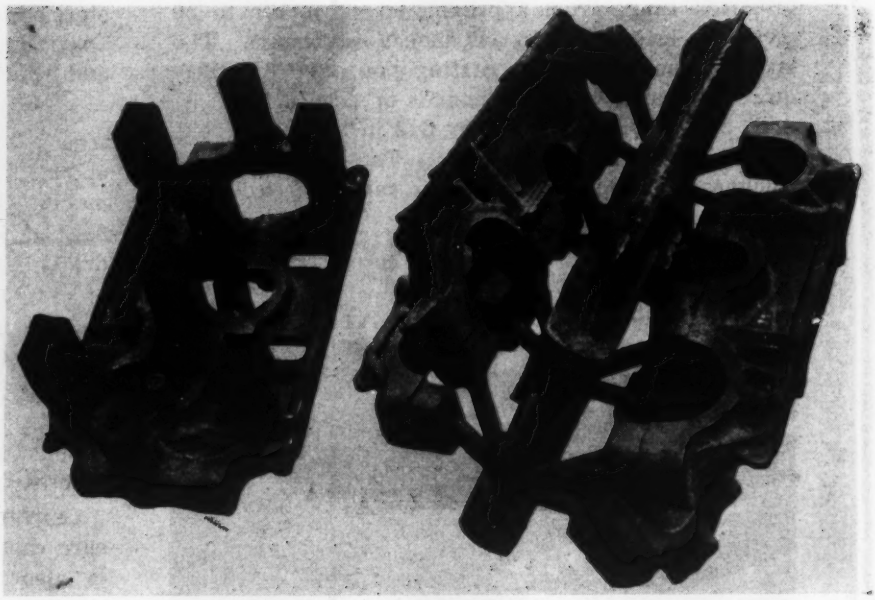


Fig. 7—Above—Centrifuged triple bearing bracket, right, and previous static casting showing greatly improved yield and decreased cleanup effected by designing for centrifugal casting

are largely those found in sand casting. Design of such parts therefore closely follows sand casting procedures. The primary advantages in centrifuging are improved metal quality, greatly increased yield and improved production by virtue of the radial-feed and stack methods, *Fig.* 7. In one instance, with 12 automatic vertical machines and 21 men, stacked molds having 144 cavities produced a maximum output of 28,800 castings per hour.

MOLDS: A variety of mold materials is used in centrifugal casting. Sand is probably the most common, especially for single pieces and large parts. Where variations in OD and flanges are necessary the cylindrical sand mold is cut away to form the desired shape. The poor thermal conductivity of sand molds, however, makes them undesirable for certain nonferrous alloys subject to segregation defects.

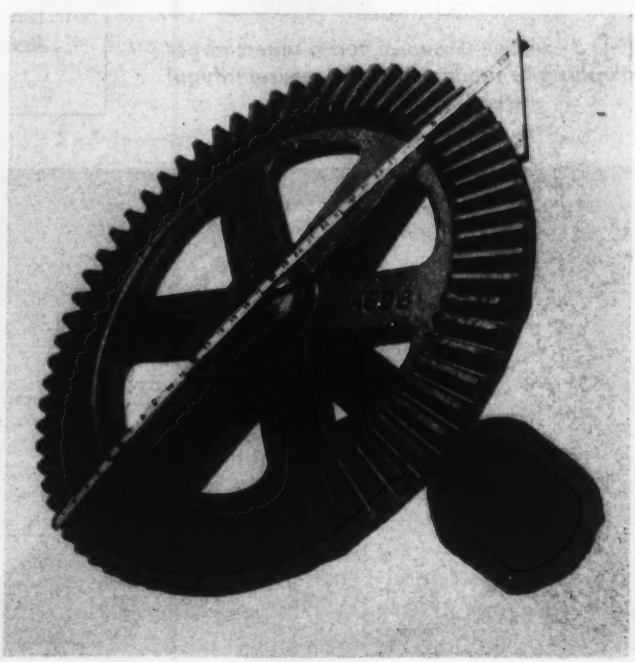
Where production quantity justifies, permanent molds are widely used. These may be of metal or graphite. Cast iron molds are used with bronzes and brasses while steel or cast iron can be used with aluminum alloys. Graphite molds have extremely high conductivity and are exceptionally well suited for parts which require maximum soundness in heavy sections. Graphite molds are suitable only for small or medium-size runs, the average being about 100 pieces per mold. With metal molds the average run is approximately 500 pieces.

DESIGN CONSIDERATIONS: Centrifugal castings, as with most production parts, may require serious consideration of the process limitations in order to obtain maximum benefits. Again, a sand casting may require some redesign to adapt it to the centrifugal method in order to obtain more uniformly sound castings. The method is especially worth consideration where circular or substantially circular parts are in view. Some machinery parts may be cast to finished or substantially complete form, *Fig.* 8. In some cases, small quantities of parts which ordinarily would be forged are successfully cast by centrifugal methods with steel quality closely approximating that in forging, *Fig.* 9.

With cylindrical parts it is preferable to limit the use of external flanges to a single flange. Flanges may be located at the ends or centrally. The casting of flanges at two ends has been done but difficulties arise in contraction of the metal.

In true centrifugal castings the need for radii adjoining flanges and other design features is not as pronounced as in sand castings but a definite radius should be used to avoid any sharp corners. Sharp corners, as in other casting processes, are detrimental to mold life. With centrifuged castings, practice

Fig. 8—Below—Centrifugally cast bevel gear having a net weight of 316 pounds



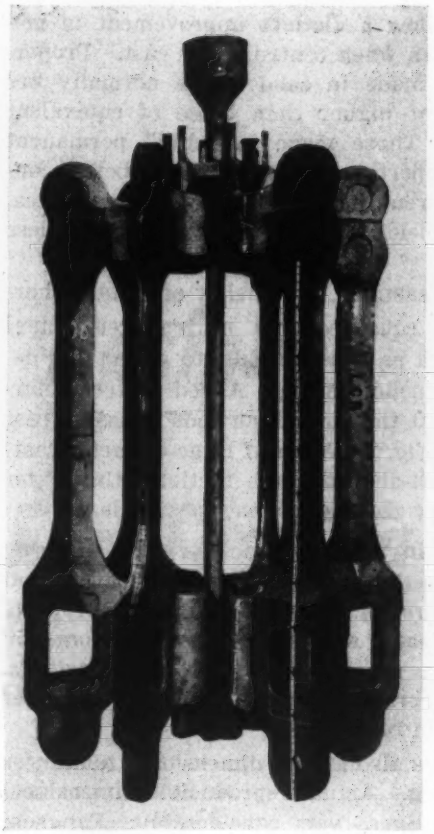


Fig. 9—Left—Group of large cast-steel connecting rods produced by centrifuging

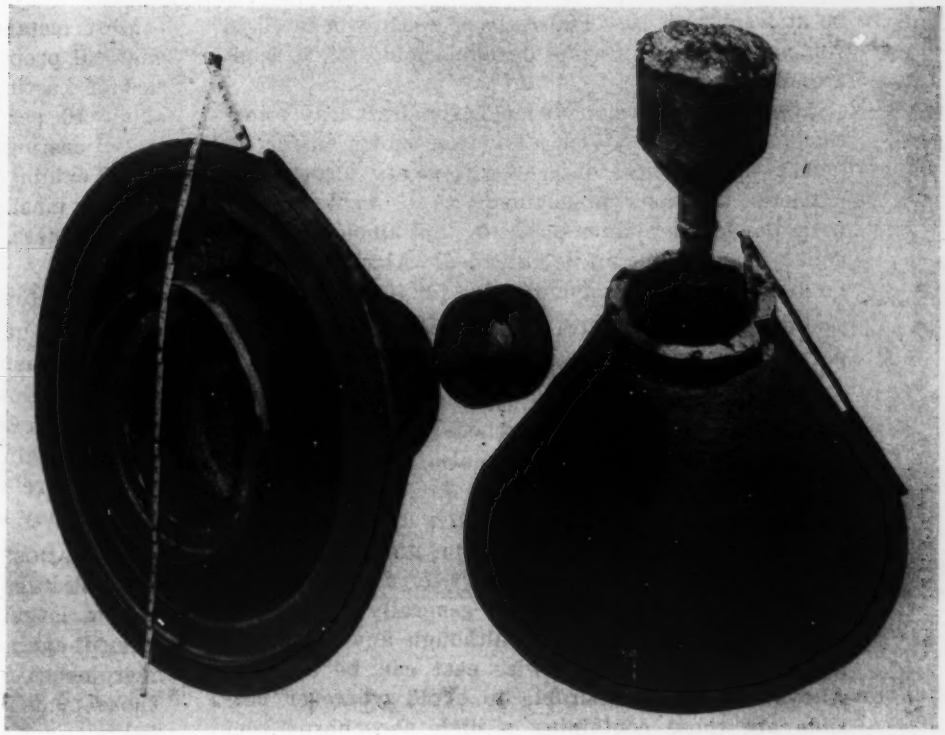


Fig. 10—Above—Tapered steel head semi-centrifugally cast in sand with internal coring to produce the desired steps in the bore

should follow that in sand casting to assure best results even though pressure feeding is available.

The external shape of true centrifugal castings may be almost any symmetrical shape—multisided, fluted, etc. It is important, however, that the mold be balanced where large parts are concerned and this factor should be borne in mind for such parts. Small parts have been made with external bosses located in a variety of positions and with a variety of heights.

Where internal contours of true centrifugal castings require flanges or other protrusions, it is necessary to increase wall thickness to suit and finish machine to the desired design. Semicentrifugal castings may be cast with internal contours largely as desired, *Fig.* 10.

Wall thickness with true centrifugal castings may range from approximately ¼-inch to 5 inches, maximum. Steel tubes under 10 feet in length and 2 feet in diameter have been cast with ¼-inch walls. As a rule, however, wall thickness must be greater, especially where machining is contemplated. With centrifuge castings thinner walls can be cast satisfactorily than in static sand casting.

Minimum Hole One Inch

Recommended minimum size of holes produced is 1-inch. Wherever holes of smaller size are desired, drilling after casting should be employed. If cored holes are desired, these should be located as near the axis of rotation as possible to insure proper feeding and progressive shrinkage. Where a hole does not run clear through a part, production will be facilitated by casting a through hole and plugging to suit after machining, *Fig.* 11.

Metal allowance for machining varies with the part design and method of casting. In sand molds the internal allowance may range from $\frac{3}{16}$-inch to 1½ inches per side depending upon the metal and the size. Ring blanks with heavy walls tend to shrink at the center of the inner bore and require an extra allowance. With permanent molds only ¼-inch, average, is required. Outside allowance ranges from $\frac{3}{16}$ to ⅝-inch on diameter. Where the surface is to be machined to a perfect finish, more metal is desirable than for cases where merely a cleanup is required. Where no fit is contemplated, as-cast finish may be satisfactory.

Where steel parts are concerned, metal allowance for machining the inside surface for press fits and general purposes is ⅛-inch per side, minimum. The average should generally be about 20 per cent of the wall thickness per side. For sliding and running fits, 30 per cent of the wall should be allowed with ¼-inch being a minimum per side. For the external surfaces the average metal allowance is ⅛ to $\frac{3}{16}$-inch with ¼-inch being a maximum per side even on walls up to 5 inches thick.

In the design of spoked wheels, gears or pulleys the problem of proper spoke size and design is important, as it also is in sand casting. Sufficient spoke area or thickness is of paramount importance to assure proper feed of metal to the rim section without premature freezing. It has been determined by extensive tests* that the ratio of spoke cross-sectional area to rim volume (that portion fed by one spoke) should

*"Centrifugal Casting of Aluminum Alloy Wheels in Sand Molds"—Northcott & Lee, *Journal of the Institute of Metals*, London, Vol. 71, 1945

"Centrifugal Casting of Copper Alloy Wheels in Sand Molds"—Northcott & Lee, *Journal of the Institute of Metals*, London, Vol. 73, Part 8, 1946-47.

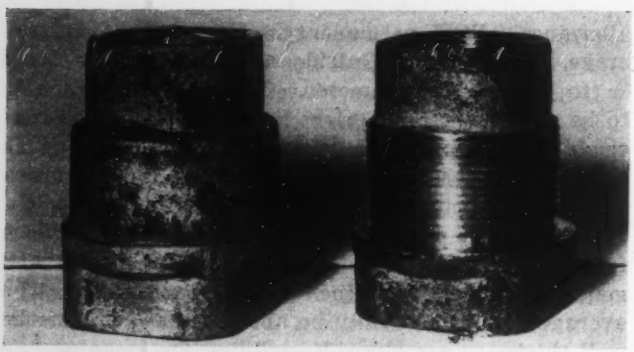
be at least 1 to 10. The ratio of spoke thickness to rim volume, in the same design, should be at least 1 to 13.

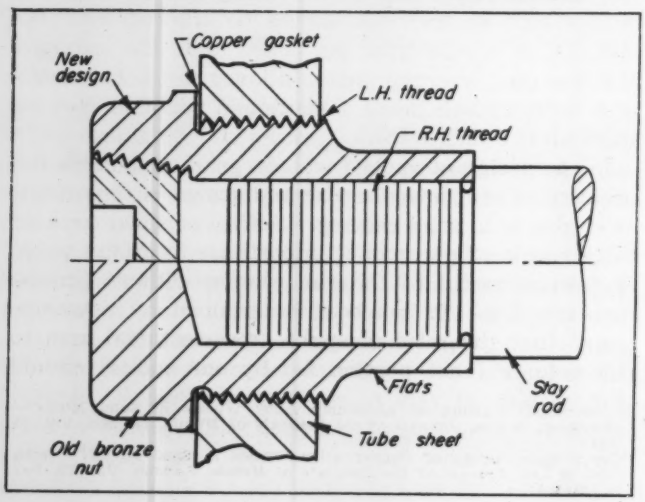
Allowance in permanent molds for draft may sometimes be needed. With cast iron molds under 10 inches in diameter, draft requirements increase as diameter decreases to as much as $\frac{1}{8}$-inch per foot with the smaller diameters. If this amount can be doubled, mold life can be extended. Above 10 inches no draft is necessary. Sand molds for true centrifugal castings require no draft but those for centrifuged parts follow usual sand casting practice.

MATERIALS: All alloys which can be sand cast can be cast by centrifugal methods. In general, steel, carbon steel, alloy steels, stainless steels, brasses, bronzes, aluminum alloys, aluminum and manganese bronzes, Monel, Everdur, plain and alloy cast irons, and copper have been cast in production.

Those alloys of aluminum with short freezing ranges have been found to be generally most desirable for centrifugal casting although any of the alloys which can be otherwise cast can be handled. Alloys which are desirable to avoid wherever possible are those containing a high phosphorus content. Phosphorus causes a high degree of "wetability" and this characteristic makes removal from the mold difficult. Also desirable to avoid are high lead (20 per cent) alloys which have a tendency to centrifuge and, also, alloys which are "hot-short", a characteristic creating cracking.

Fig. 11—Below—Bronze condenser stay rod nut as centrifugally cast at lower cost than the original design machined from bar stock





Most metals show a distinct improvement in mechanical properties when centrifugally cast. Properties of castings made in sand molds normally are about 10 per cent higher than those of equivalent static castings. Those made in "chill" permanent molds exhibit properties 30 to 40 per cent better considering tensile strength, elongation, reduction in area, and hardness. Yield strength, however, is much less affected.

In centrifuged castings, the quality of metal is normally not quite equal to that in true centrifugal castings inasmuch as it is difficult to obtain the desired directional solidification. Added material normally is allowed at the central portions to assure best possible quality, *Fig.* 7. Again if large-diameter castings require small-diameter hub sections, the center portion may show distinctly lower physicals.

TOLERANCES: In the production of cast parts by the centrifugal method, the tolerances typical in sand casting largely prevail. Surface roughness of parts formed against sand may range upward from 250 microinches, rms, as is typical with sand castings. Those made in permanent molds usually are under 250 microinches in roughness.

Metal shrinkage also affects dimensional tolerances as in sand casting. Actual reproducible dimensional accuracy therefore may vary considerably. For most parts and especially semicentrifugal and centrifuged castings, the tolerances applied should follow those covered in TABLE V, Part XLV, of this series. Typical tolerances applicable range from plus or minus $\frac{1}{16}$-inch to $\frac{1}{8}$-inch. Some true centrifugal castings can be held to plus or minus $\frac{1}{32}$-inch on outside diameters and uniformity of wall thickness when desired. Once the foundry procedures have been properly adjusted and experimental testing completed, it is possible to produce some parts to even better tolerances, *Fig.* 3. In some instances, tolerances of plus or minus $\frac{1}{64}$-inch on external dimensions may thus be realized. Owing to variation in charging weight, however, inside diameter tolerances on true centrifugal castings ordinarily will be plus or minus $\frac{1}{16}$-inch or greater. As has been indicated, wall thickness with vertical true centrifugal castings is normally greater at the bottom than the top depending upon the speed at which the mold is rotated.

Collaboration of the following organizations in the preparation of this article is acknowledged with much appreciation:

Allis-Chalmers Mfg. Co. (*Fig.* 11) ..... Milwaukee, Wis.
American Cast Iron Pipe Co. .....
(*Figs.* 1, 2, 3, 4 and 6) ..... Birmingham, Ala.
Falk Corp. (*Figs.* 7, 8, 9 and 10) ..... Milwaukee, Wis.
Lebanon Steel Foundry Co. (*Fig.* 5) ..... Lebanon, Pa.
Sandusky Foundry & Machine Co. ..... Sandusky, Ohio
Shenango-Penn Mold Co. ..... Dover, Ohio

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2. *Process Control of Brass and Bronze Foundry Procedure (SP-52)*, Brass and Bronze Subcommittee, Society of Automotive Engineers, New York, 1949.
3. *Process Control of Aluminum Foundry Procedure (SP-8)*, Aluminum Castings Committee of SAE War Engineering Board, Society of Automotive Engineers, New York, 1945.

Designed For Testing

MAXIMUM testing accuracy and minimum testing time and expense were the primary goals in designing a test floor for centrifugal pumps at the West Allis works of the Allis-Chalmers Mfg. Co. New provisions for set-up, equipment for water measuring and methods of determining accurately the power requirements of commercial pumps have reduced the time required to test a standard pump from four to about one hour.

Among the outstanding features of the test stand are the movable, hydraulic-powered motor bed and pump pedestal permitting the operator to line up pump and motor quickly by means of control levers, without time-consuming shimming and shifting of the motor. The pump test table is mounted on a hydraulic cylinder for vertical adjustment and is held in place by a hydraulically operated clamp. Sidewise movement and slight turning of the pump table in a horizontal plane are also possible, the motor bed being movable in a plane toward or away from the

Fig. 1 — Top — General view of test stands. Movable motor bed is clearly shown in the foreground, with pump discharge lines leading to weigh tanks at left

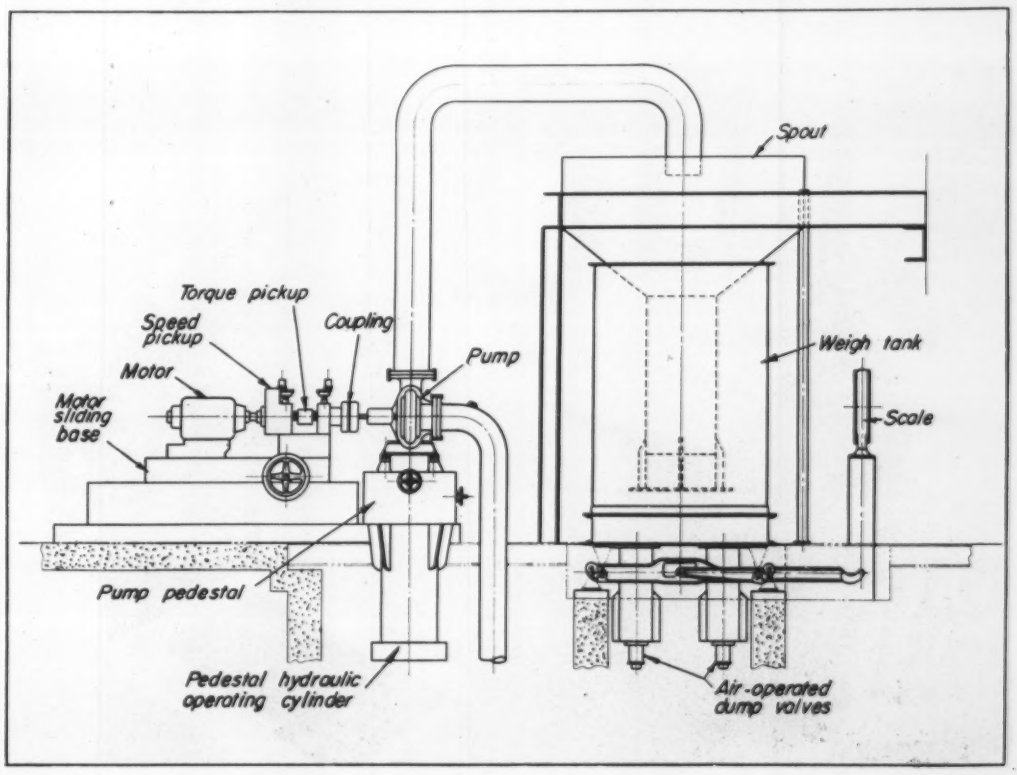

Fig. 2—Right — Outline drawing showing complete test stand including motor, pump and adjustable pedestal, weigh tank, and scale

pedestal-mounted pump. Thus, pumps being tested can be lined up in all three planes with a minimum of time-consuming, cut and try set-up.

Torque measurement utilizes a Baldwin Type T strain gage pickup carrying the full torque between pump and motor. Speed measurement is obtained to an extremely high degree of accuracy by comparing the frequency of a generator driven by the test motor to a standard, known frequency generated by a tuning fork. The difference between these two frequencies is used to obtain speed readings accuate to within one rpm.

Flow measurement is accomplished using weigh tanks with automatic dump valves. Photoelectric cells mounted on the dial of the weighing scale actuate control circuits to start and stop tests. Motor speed, torque, and pump discharge and inlet pressures are all recorded continuously during the test period, recording meters and the test timers being controlled by the photoelectric circuit. All controls, meters, gages and recorders are located in an enclosed control room with the exception of the discharge pressure valve which is set before the start of each test.

Stand Includes Time-Saving Devices

Other novel features designed to reduce set-up and test time include gage lines that can be quickly connected to the appropriate gage on the control panels by self-sealing coupling plugs, quick-acting clamps on power leads to two and four-speed motors, and limit switches on pump pedestals so that the motor is stopped if the pump table should settle and throw the drive shaft out of line.

In testing condensate pumps, where a liquid is to be removed from a space in which the pressure is low, suction is taken from a "dummy condenser". This condenser is a large tank containing perforated plates through which water from the storage tanks is pumped, steam air ejectors maintaining the required vacuum in the condenser.

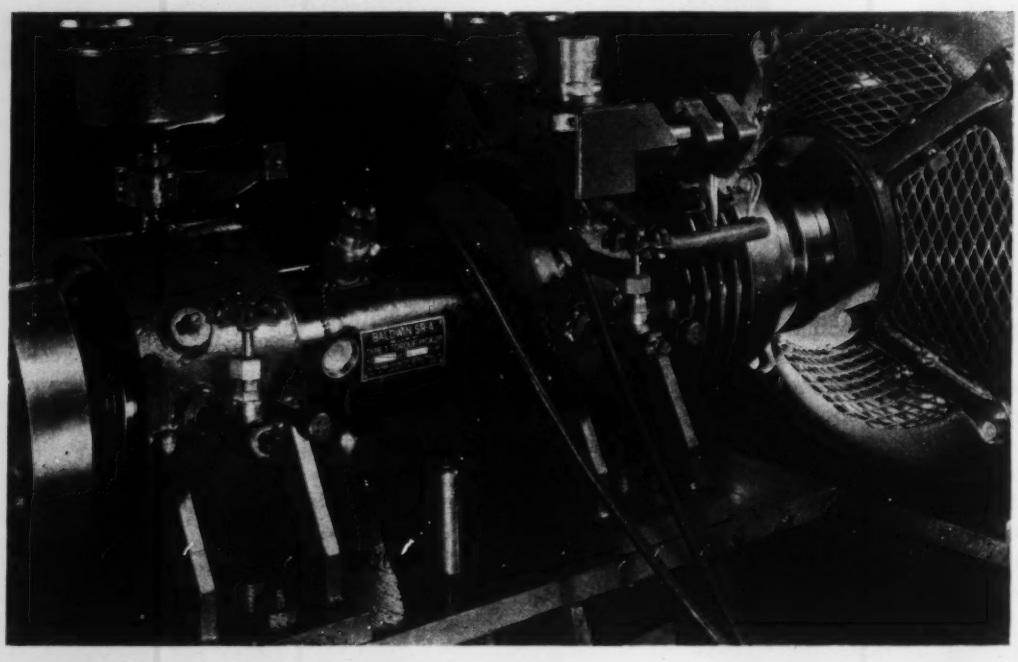

Fig. 3—Above—View of coupling between pump and motor. Torque pickup is at center, speed generator with cover removed to show slip rings is shown at right center

Fig. 4—Left—Interior of control room. Gage lines, speed and torque meter connections from any one of three test stands are readily hooked up to test panels shown here

The Electronic Analogue

A DESIGN TOOL

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USE of analogues in the study and design of complicated dynamic systems is rapidly becoming widespread. The authors have also used the analogue as an extremely effective educational tool in the teaching of dynamics and design since 1945. The analogue used is of the fast type which produces repeating solutions at the rate of sixty per second and which may be conveniently viewed by oscillographic means.

Advantages of this method of analysis are many. Because of the rapidity of solution and ease with which the parameters of the system may be changed, a large number of solutions can be carried out in a very short time. Thus the influence of changes in the various limiting variables can be quickly determined. This makes possible the treatment of nonlinear systems by assuming linearity over a very small range and carrying through a solution with a given set of values, repeating the procedure using parameter values which exist at the point of operation.

This method can be readily understood by considering the torque-speed characteristics of a variable pitch propeller whose static operating characteristics are shown in *Fig.* 1. In this example, at some point of operation such as *O* the following relationship holds for small changes in operating conditions:

$$dM = \left(\frac{\partial M}{\partial \omega}\right) d\omega + \left(\frac{\partial M}{\partial \beta}\right) d\beta \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For small finite changes in pitch angle and speed the following relation describes the approximate behavior of the system:

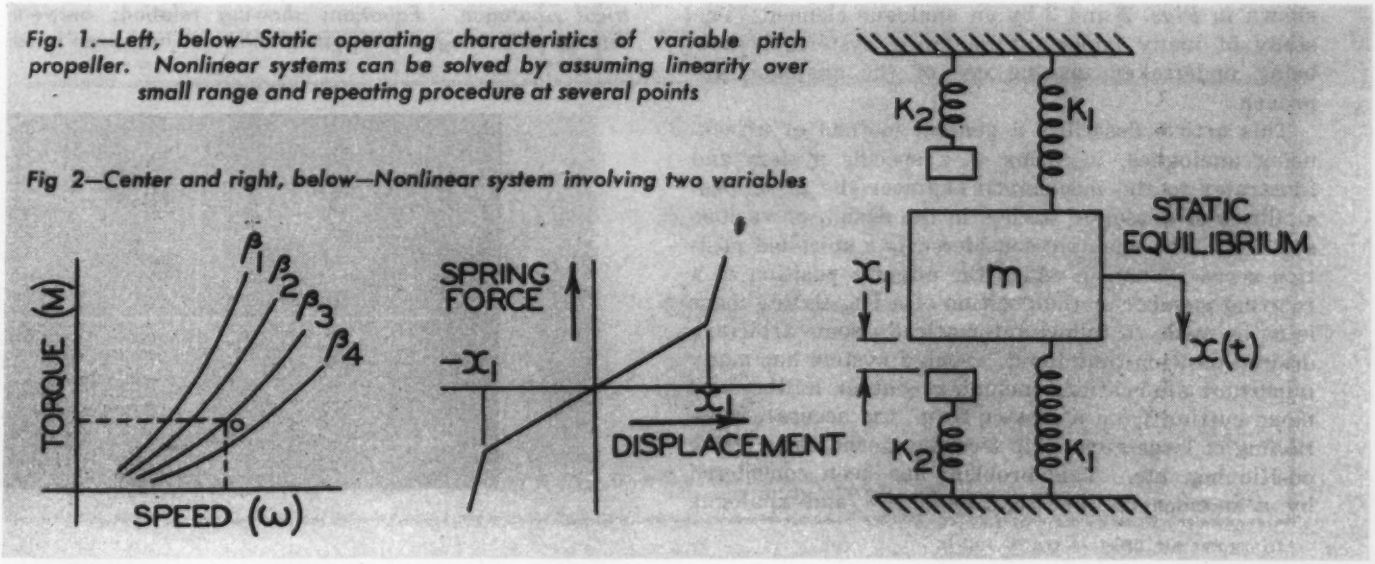
$$\Delta M = K_\omega \Delta\omega + K_\beta \Delta\beta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where $K\omega$ and $K\beta$ are the values of $\partial M/\partial\omega$ and $\partial M/\partial\beta$ at the point *O*. Use of Equation 2 permits linear analysis. Repeated solutions in which the values of $K\omega$ and $K\beta$ at other operating points are used will yield performance characteristics of the system over its entire range of operation. In the variable pitch propeller example, torque is a function of both speed and pitch angle.

In a wide number of important problems, nonlinearity exists in a relationship involving only two

Fig. 1.—Left, below—Static operating characteristics of variable pitch propeller. Nonlinear systems can be solved by assuming linearity over small range and repeating procedure at several points

Fig 2—Center and right, below—Nonlinear system involving two variables



Nomenclature

General

B = Equivalent damping constant, ($B = B_L + B_m r^2{}_1$) in-lb sec per radian
C = Capacitance, farads
e = Variable voltage, e_i = input; e_o = output, volts
i = Variable current, amps
J = Equivalent moment of inertia about axis of rotation, $J = J_L + J_m r^2$, in-lb sec^2 per radian
K = Constant coefficient
M = Torque, in-lb
m = Mass, lb sec^2 per in.
r = Gear ratio, number larger than unity
s = Subscript to denote steady-state condition of a variable
t = Time, sec
u = Deviation or error, $u = \theta^* - \theta$, radians or volts
x = Linear displacement, in
β = Propeller blade angle
γ = Time scale constant
θ = Angular position, output, radians or volts
θ^* = Angular position desired, input, radians or volts
τ = Time constant, sec
ζ = Damping ratio
ω = Angular speed, radians per sec

Specific

e_1 = Dc voltage proportional to deviation u, volts
e_2 = Amplifier output, volts
e_g = Generator output, volts
i_f = Generator field current, amps
i_a = Motor-generator armature current, amps
M_m = Motor torque, in-lb
M_L = Load torque, in-lb
M_{Fr} = Friction and/or damping torque, in-lb

variables, such as illustrated in *Fig.* 2. A number of other systems exhibit the phenomenon of saturation. The d-c motor is an example, *Fig.* 3 showing the torque-armature current characteristics of such a motor. Mr. George Welti[1] of the dynamics and control laboratory, department of mechanical engineering, Massachusetts Institute of Technology, has developed methods of representing nonlinearities of the type shown in *Figs.* 2 and 3 by an analogue element. The study of many important nonlinear systems is now being undertaken making use of the analogue approach.

This article describes a general method of attack, using analogues, in terms of a specific system and illustrates to the mechanical engineer the great possibilities of analogue studies in the design of various systems. The example considered is a so-called position servo system in which the angular position of a rotating member or the position of a translating mass is to be made to follow automatically some arbitrary desired position-time input. Such a system has many important applications including contour milling and flame cutting from a master form, the accurate positioning of large guns, ship steering mechanisms, valve positioning, etc. This problem has been considered by a number of investigators,[2, 3, 4, 9] and analogue studies of this type of system have been reported by others.[5, 6] Symbols used in this article are those proposed by G. A. Philbrick.[7]

The basic system which is to be controlled is shown in *Fig.* 4 and the control system is illustrated schematically in *Fig.* 5. A disk with moment of inertia about the axis of rotation J is subjected to a load torque M_L and a friction torque M_{Fr}, *Fig.* 4. In the presence of these loads its angular position θ is to follow an arbitrarily desired positional value θ^* and necessary corrections are to be produced by introducing a driving torque M. To accomplish the desired result the position θ must be measured and compared with the desired position θ^* using a mechanical or electrical differential. Use of electrical equipment permits remote location of the input station and produces the difference, $\theta^* - \theta$, as a voltage, which is desirable if an electrical system is to be used to deliver the correcting torque M.

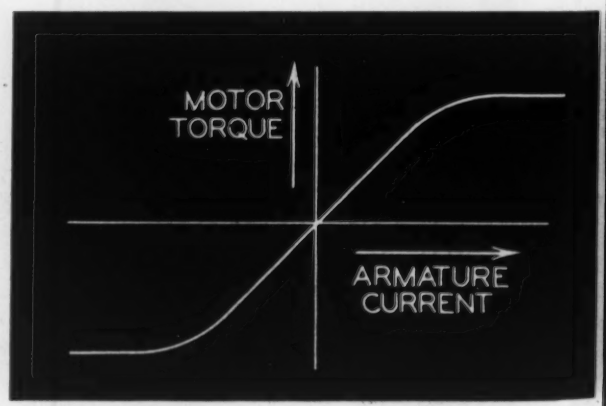
Measuring System Has Low Energy Output

The measuring system may be represented as shown in *Fig.* 6. It must be capable of producing accurate results at speeds where the main system is expected to operate. Such specifications usually imply lightweight, low-force elements with little energy-storage capacity. The instrument output is therefore at low energy level. In the illustrative problem a synchronous transformer, *Fig.* 7, will be directly coupled to the shaft θ and a synchronous transmitter to the

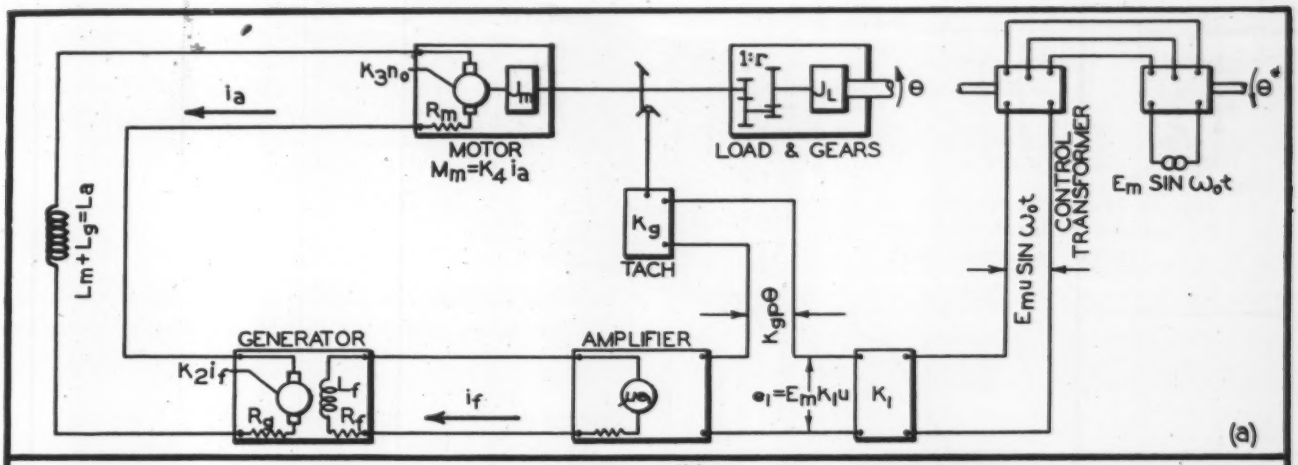
Fig. 3—Left, below—Torque-armature current characteristics of d-c motor, which can be treated using the analogue approach even though nonlinear in nature

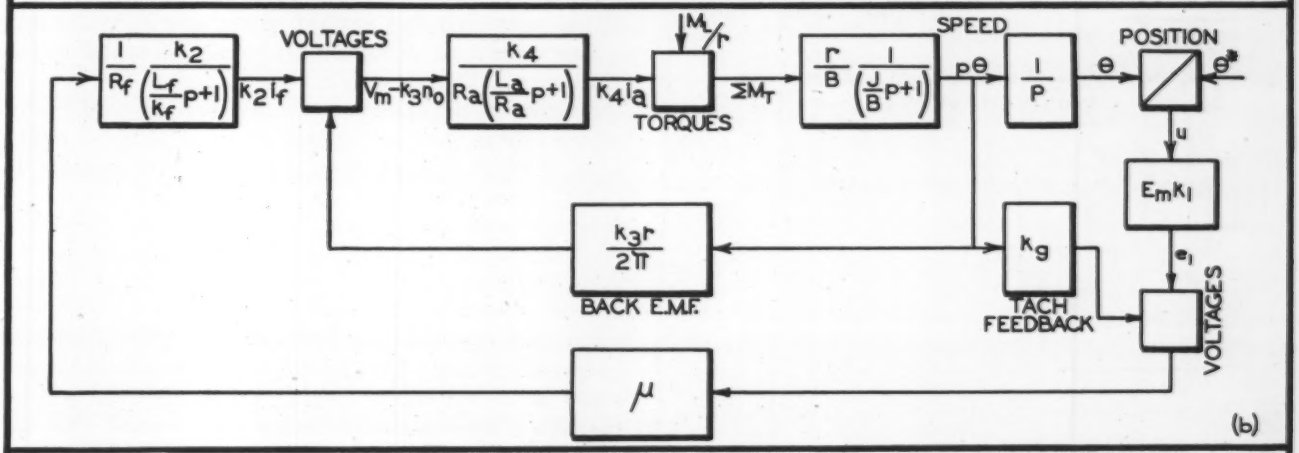
Fig. 4—Center, below—Basic system which is to be controlled. Disk is to be made to follow an arbitrarily desired positional value

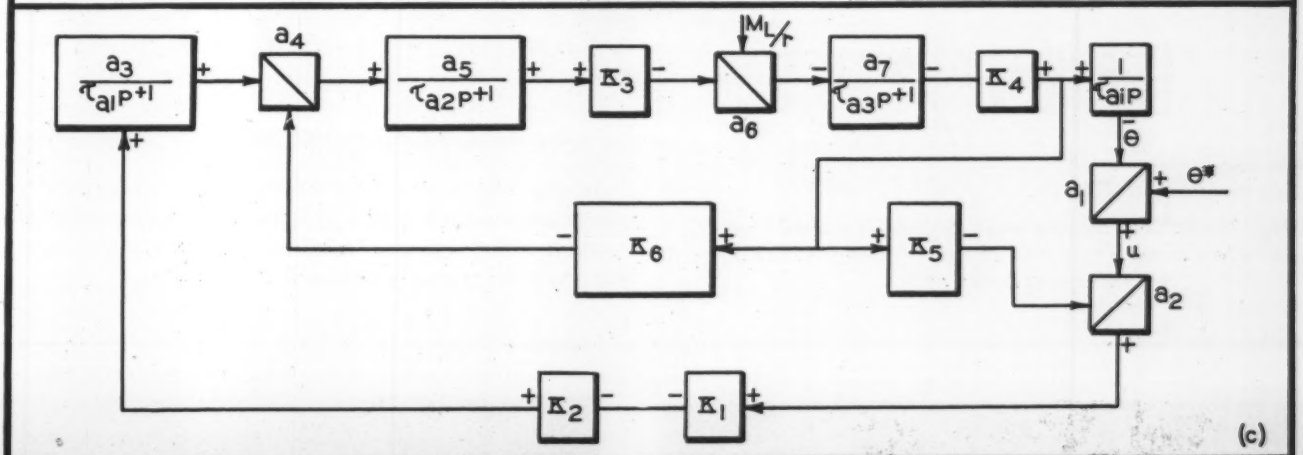
Fig. 5—Opposite page—Schematic diagram of basic system shown in Fig. 4. Each mechanical or electrical element of prototype system is shown by a block in (a). In (b) the actual system is shown in block form and (c) gives its electrical analogue. Equations showing relations between settings on analogue and system constants are given in (d)

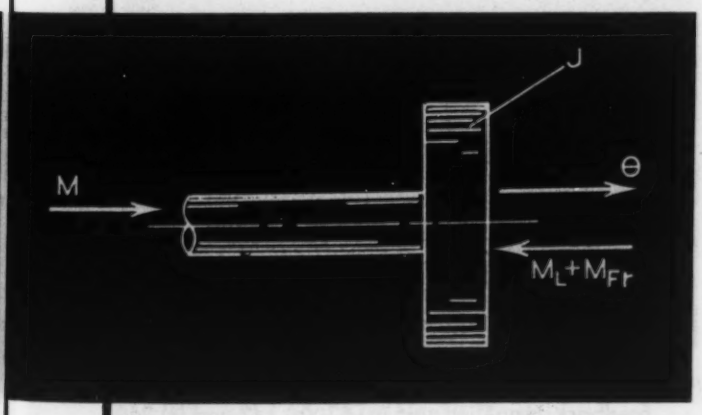


[1] References are listed at end of article.









$$K_3 = \frac{1}{a_4 \cdot a_5} \times \frac{K_4}{R_a}$$

$$K_4 = \frac{1}{a_6 \cdot a_7} \times \frac{r}{B}$$

$$K_5 = \frac{a_1 K_g}{\tau_{ai} \gamma E_m K_1}$$

$$K_6 = \frac{K_3 r}{2\pi}$$

$$K_1 \times K_2 = \frac{\tau_{ai}\gamma}{a_3 \cdot a_1 \cdot a_2} \times E_m K_1 \mu \frac{K_2}{R_f}$$

$$\gamma \tau_{a1} = \frac{L_f}{R_f} = \tau_1$$

$$\gamma \tau_{a2} = \frac{L_a}{R_a} = \tau_2$$

$$\gamma \tau_{a3} = \frac{J}{B} = \tau_3$$

γ = TIME SCALE FACTOR

(d)

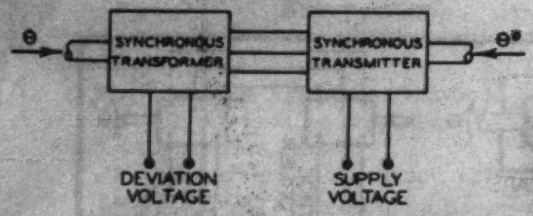


Fig. 7—Above—Synchronous transmitter coupled to input shaft and transformer to output shaft

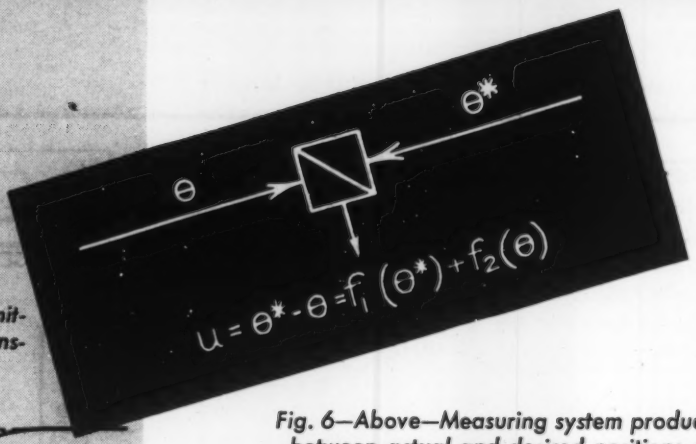


Fig. 6—Above—Measuring system produces difference between actual and desired positions as a voltage

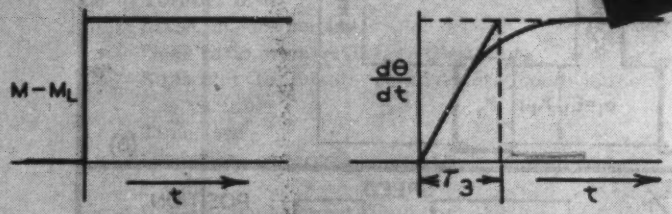


Fig. 8—Above—Values of dθ/dt resulting from a step change in net torque

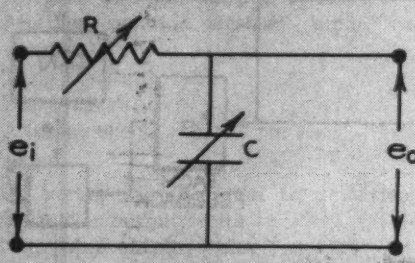


Fig. 9—Above—System characterized by differential equation similar to Equation 3

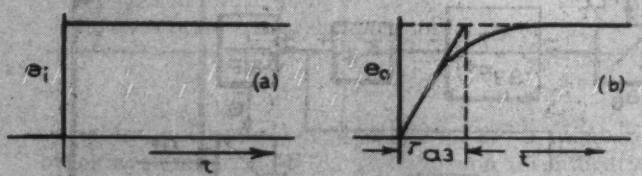


Fig. 10—Above—Square wave disturbance shown at (a) when applied to circuit of Fig. 9 produces output voltage e_o shown at (b)

desired position or input shaft θ^* in the manner shown.

As shown in *Fig. 5a,* the deviation voltage e_i is detected, amplified and applied to the field of a d-c generator driven at substantially constant speed by an a-c motor. The resulting voltage across the generator armature is applied to the armature of a d-c motor whose field is held at constant voltage. The d-c motor torque, which is proportional to armature current up to the saturation point, is amplified through a gear reduction unit directly coupled to the rotating member *J*. Velocity of the output shaft may be measured by a tachometer generator, shown on shaft J_m. Means are provided for subtracting from the error or deviation signal a predetermined fraction of the tachometer generator voltage. This voltage may be directly combined with the error signal or it may be passed through a filter network before combination with the error signal. This arrangement has been widely used and is generally called tachometric or velocity feedback.

Dynamic Relationships Between Systems

In *Fig. 5a,* each block represents a mechanical or electrical element of the electro-mechanical prototype system. The dynamic relationships existing between the variable quantities of each system are:

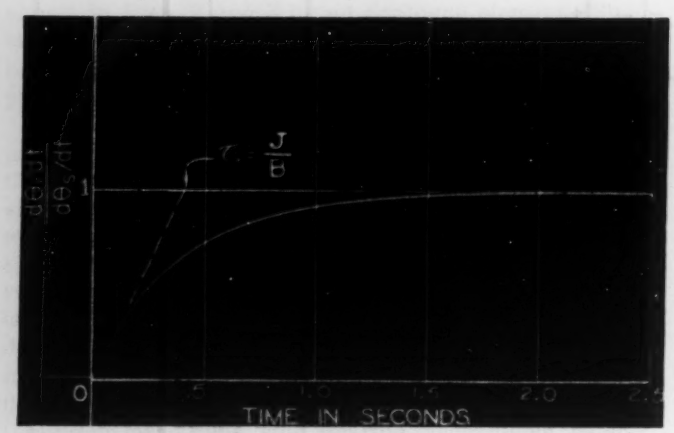


Fig. 11—Above—Observed data showing response of rotating inertia to step change in torque

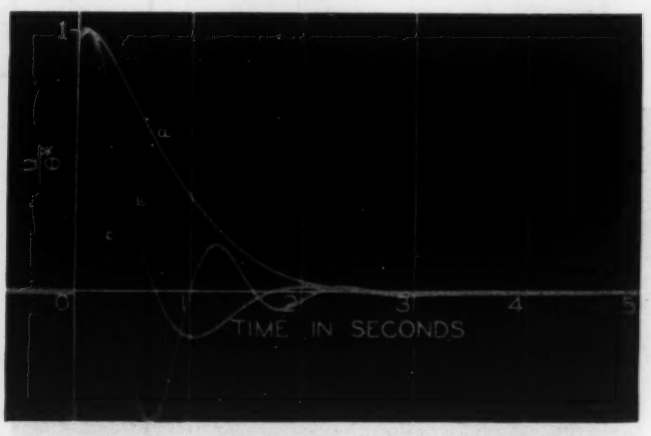


Fig. 12—Step change in θ gives these u/θ* values. No feedback; amplifier gain (a) 52, (b) 142 and (c) 260*

Rotating Member:

$$M - M_L = J\frac{d^2\theta}{dt^2} + B\frac{d\theta}{dt} \quad \ldots\ldots (3)$$

Measuring System:

$$u = \theta^* - \theta \quad \ldots\ldots (4)$$

$$e_1 = E_m K_1 u \quad \ldots\ldots (5)$$

Amplifier:

$$e_2 = \mu e_1 \quad \ldots\ldots (6)$$

Generator:

$$e_2 = R_f i_f + L_f\frac{di_f}{dt} \quad \ldots\ldots (7)$$

$$e_g = K_2 i_f \quad \ldots\ldots (8)$$

Motor:

$$e_a = \frac{K_4 r}{2\pi}\left(\frac{d\theta}{dt}\right) + (R_g + R_m)\, i_a + (L_g + L_m)\frac{di_a}{dt} \quad \ldots\ldots (9)$$

$$M_m = K_4 i_a \quad \ldots\ldots (10)$$

Gear Reducer:

$$M = M_m r \quad \ldots\ldots (11)$$

$$\theta = \frac{\theta_m}{r} \quad \ldots\ldots (12)$$

The preceding equations are characteristic of many systems and the operations of addition and integration indicated can be successfully carried out in a number of ways. Values of $d\theta/dt$ resulting from a step change in net torque, $M - M_L$, are shown in *Fig.* 8, where $\tau = J/B$ is known as the time constant of the system. The system shown in *Fig.* 9 is characterized by a differential equation similar in form to Equation 3. The systems shown in *Figs.* 4 and 9 are analagous systems since their behaviors are represented by differential equations of the same form. Behavior of the mechanical system may be studied by working with the more easily constructed and more flexible electrical circuit. In general, it is convenient to make the time constant of the electrical circuit, τ_{aS}, small, as this results in small inexpensive components and a fast solution. Square wave disturbances similar to the one which is illustrated in *Fig.* 10*a* can be readily produced.

Such a disturbance applied to the circuit of *Fig.* 9 would produce the output voltage e_o shown in *Fig.* 10*b*. The RC product must be chosen to be a fraction of the pulse to insure that the transient of the network is over before the system is again disturbed. Values of $C = 0.001$ − microfarad and $R = 1$ megohm

Numerical Values Used In Experimental System

Quantity	Symbol	Numerical Value	Units
Detector constant	k_1	0.9	volt per volt
Peak value of supply voltage	E_m	81.2	volts
Amplifier gain	μ	52, 142 & 260	
Amplifier resistance	R_p	10,000	ohms
Gen. field resistance	R_f	1380	ohms
Gen. field inductance	L_f	16	henries
Combined motor and generator armature inductance	L_a	0.442	henries
Generator constant	k_2	1500	volts per amp
Combined motor and generator armature resistance	R_a	60	ohms
Motor torque constant	k_4	2.90	in-lb per amp
Motor back-voltage constant	k_3	2.06	volts per motor rps
Motor armature inertia	J_m	3.91×10^{-4}	in-lb-sec²
Load inertia	J_L	1.874	in-lb-sec²
Gear ratio (negligible inertia)	r	100	
Moment of inertia (referred to output shaft)	J	5.78	in-lb-sec²
Motor damping	B_m	0.00144	in-lb-sec per radian
Total damping (assume B_L negligible)	$B = B_m r^2$	14.4	in-lb sec per radian

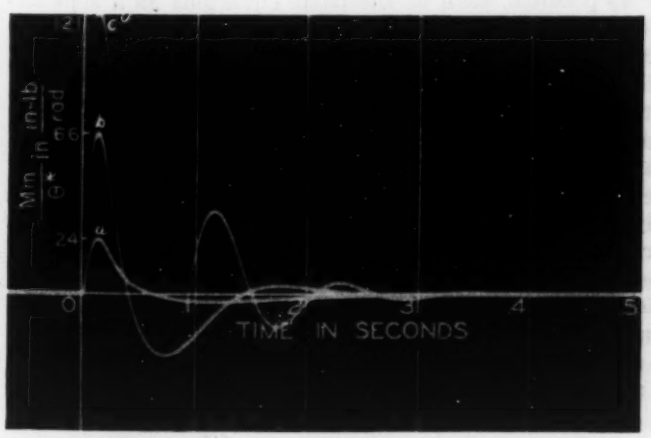


Fig. 13—Ratio M_m/θ^* resulting from step change in θ^*. Settings as in Fig. 12

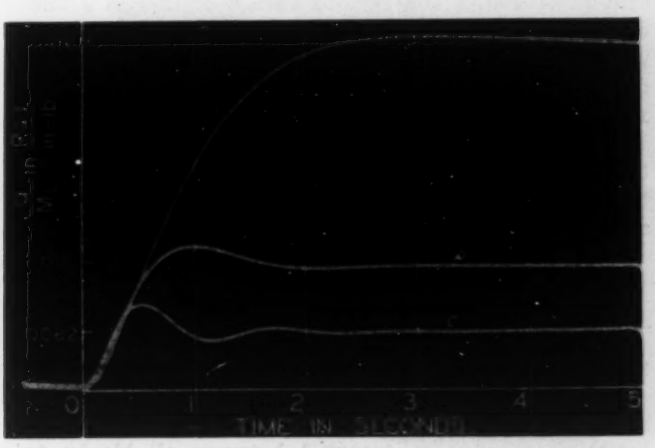


Fig. 14—Step change in load torque M_L produces these values of u/M_L. Settings as in Fig. 12

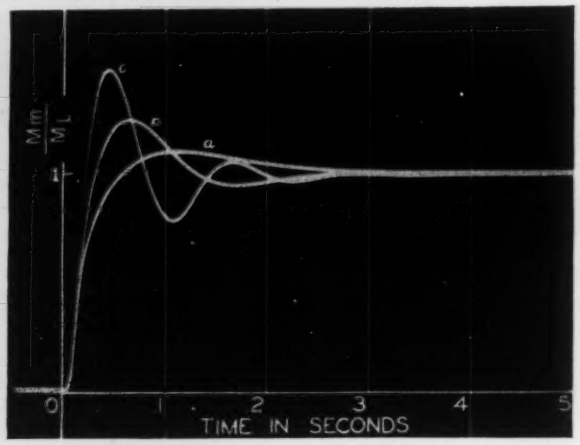


Fig. 15—Ratio M_m/M_L resulting from step change in load torque M_L. Settings as in Fig. 12

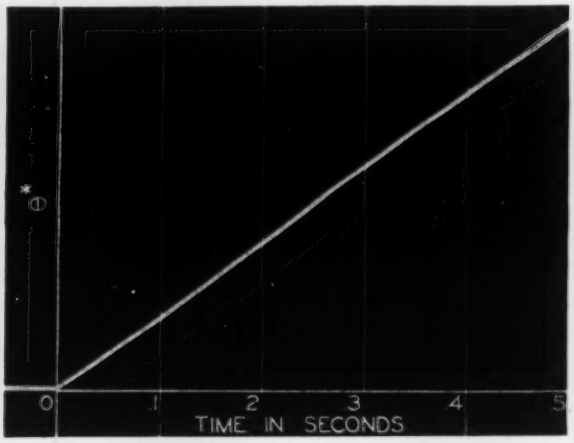


*Fig. 16—Step disturbance on rate of change of desired value θ**

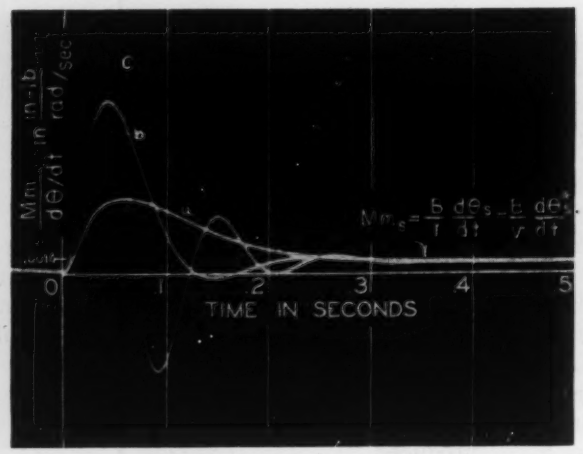


Fig. 19—Manipulated variable M_m resulting from a step disturbance on the rate of change of the desired value θ. Settings as in Fig. 12*

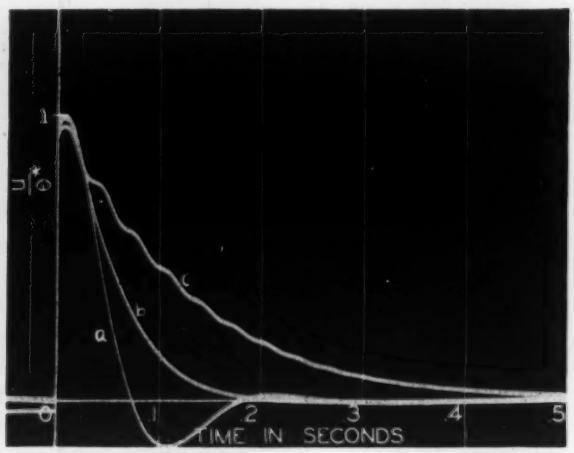


Fig. 20—System same as Figs. 4 and 5 with feedback constant k_g varied, amplifier gain at 142. Settings of k_g (a) 0, (b) 0.018-sec and (c) 0.072-sec

would be satisfactory values for the disturbance shown. A study of the behavior of the mechanical system of *Fig.* 4 for various values of inertia J and damping B can be made by using the RC network and varying values of the resistance R. The observed data for such an investigation are shown in *Fig.* 11. Here the ratio of output to input voltage is plotted against time. The time scale has been adjusted by the ratio $\gamma = 120$ in the photographic printing process, thus allowing results to be interpreted directly as the solution to Equation 3 for a step change in torque.

Closed Loop Shown As Networks

The remaining elements in the closed loop system may in a similar manner be represented by simple electrical networks. *Fig.* 5*b* shows in block form the actual system and *Fig.* 5*c* an electrical analogue of it. Isolation stages are inserted between all blocks to prevent interaction of elements. *Fig.* 9 represents in analogue form a damped rotating disk only if the full current flows at all times through the condenser C. Voltage e_g must therefore be applied to the grid of an isolation stage. It is desirable to represent, as far as possible, each of the basic equations as a separate analogue element, rather than to combine and reduce them. In combination, many of the physical properties lose their separate identity and make it extremely difficult to investigate the influence of changes in their values. However, many constants that multiply or divide together to form a constant coefficient may be more readily represented by a single analogous coefficient. This prevents unnecessary amplification followed immediately by attenuation. It will be noted that in the analogue used in this example, torque, angular velocity and angular displacement are represented by voltages. *Figs.* 5*a*, *b*, and *c* show in detail the progressive steps taken in moving from the actual system schematic diagram to a block diagram and then to a block diagram of the analogue components. It may be noted that attenuations (a_1, a_2, a_3 . . . . .) which are introduced by the analogue and certain of the physical constants are necessarily combined. Attenuations

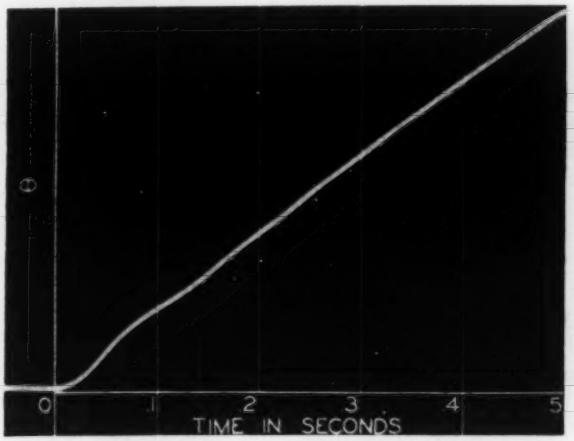


Fig. 17—Typical output, θ, for a step disturbance on rate of change of desired value θ^*

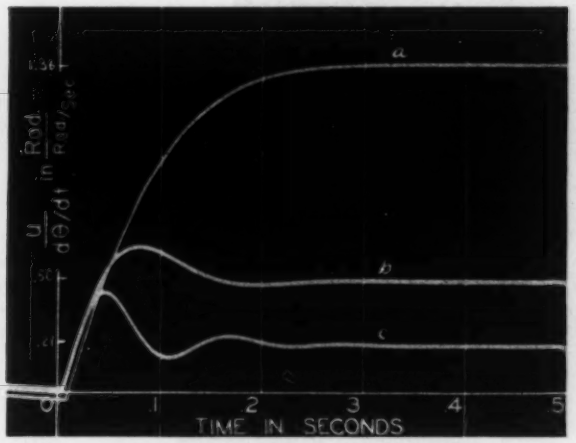


Fig. 18—Deviation caused by a step disturbance on rate of change of θ^*. Settings as in Fig. 12

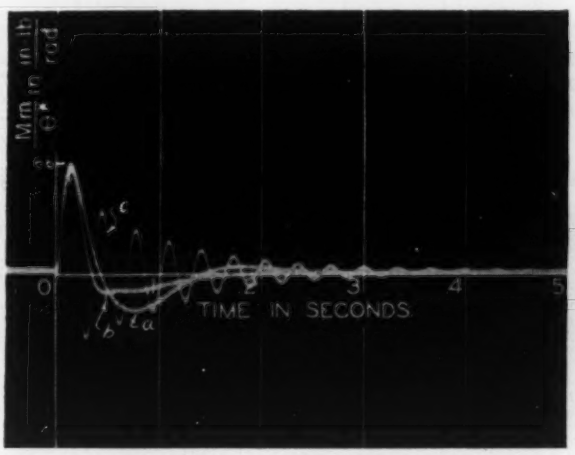


Fig. 21—Undesirable increase in steady-state velocity error due to addition of velocity feedback. Conditions as in Fig. 20

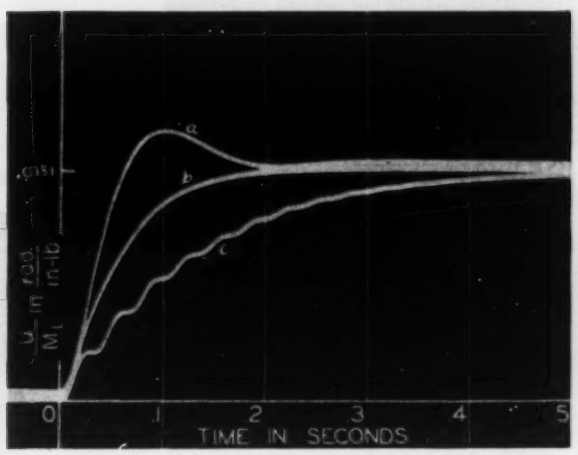


Fig. 22—Unit step change in load torque M_L results in these u/M_L curves, conditions same as Fig. 20. Compare with Fig. 14

unavoidably introduced by the analogue are exactly compensated by increases in gain of following amplifiers. The equations in *Fig. 5d* show the relation between the settings on the analogue and the system constants which they represent.

Calibration of the analogue is achieved by checking the response of each element to a square wave disturbance against analytic solutions of the basic equations. An additonal check is made by disturbing the analogue system with all elements connected in closed loop and comparing with an analytic solution for the combined linear system.

RESULTS: In order to present typical quantitative results, actual values from a real system were set into the analogue. These values were suggested by a problem appearing in *Principles of Servomechanisms* by Brown and Campbell.[10]

The electrical square wave duration of 1/240-sec was assigned to represent 0.5-sec of actual time with reference to the actual system. Thus the time scale change γ was determined to be 120. Time constants to be set into the analogue were determined by means

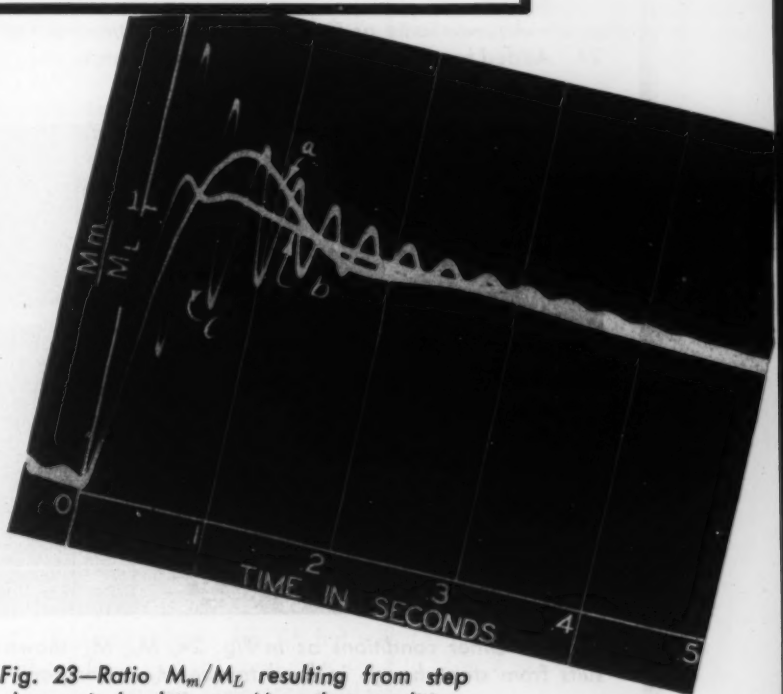


Fig. 23—Ratio M_m/M_L resulting from step change in load torque M_L, other conditions as in Fig. 20. Compare with Fig. 15

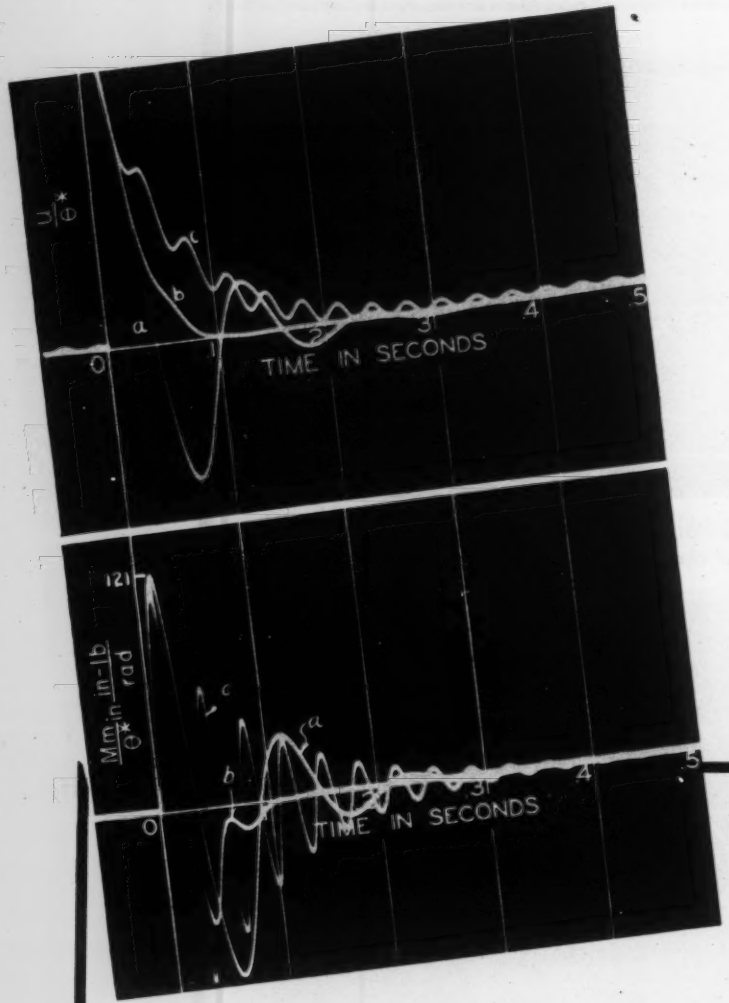


Fig. 24—Top—Curves showing u/θ^* for conditions of Fig. 20 with amplifier gain of 260 and k_g settings (a) 0, (b) 0.016-sec and (c) 0.036-sec. Optimum error performance with position disturbance and tachometric feedback shown by (b)

Fig. 25—Above—Same as Fig. 21 but for conditions of Fig. 24. Added feedbeck causes increased steady-state error

of equations of *Fig.* 5*d* from the following system time constants:

$$\tau_1 = \frac{L_f}{R_f} = 0.0014\text{-sec} \quad \text{Thus: } \tau_{a1} = \frac{\tau_1}{\gamma} = 1.17 \times 10^{-5}\ \text{sec}$$

$$\tau_2 = \frac{L_a}{R_a} = 0.0074\text{-sec} \qquad \tau_{a2} = \frac{\tau_2}{\gamma} = 6.14 \times 10^{-5}\ \text{sec}$$

$$\tau_3 = \frac{J}{B} = 0.403\text{-sec} \qquad \tau_{a3} = \frac{\tau_3}{\gamma} = 3.36 \times 10^{-3}\ \text{sec}$$

The remaining coefficients to be set into the analogue were also determined from equations of *Fig.* 5*d*. They are: $K_1K_2 = 11.6$; $K_3 = 0.193$; $K_4 = 26.9$; $K_5 = 0.046$; k_{ag}, $(k_{ag} = \gamma\, kg)$; $K_6 = 32.8$.

Response curves of error and manipulated torque (output motor torque) resulting from step disturbances of desired position (θ^*) and load torque are shown in *Figs.* 12 to 15. Three values of amplifier gain were used:

Amplifier gain	Character of Transient Response
52	Critically damped, $\zeta = 1.0$
142	11 per cent overshoot, $\zeta = 0.5$
260	Oscillatory, $\zeta = 0.3$

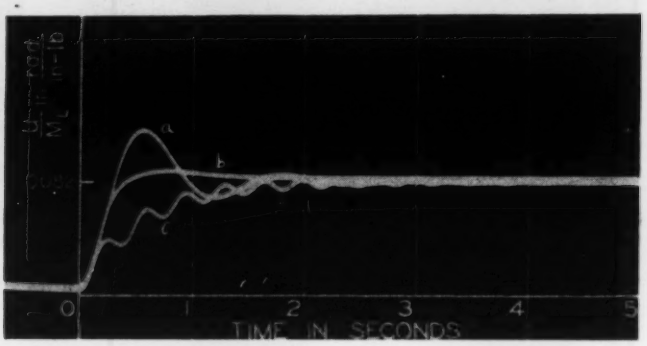


Fig. 26—Resulting u/M_L from a unit step change in load torque M_L, other conditions as in Fig. 24. Higher amplifier gain gives lower steady-state error

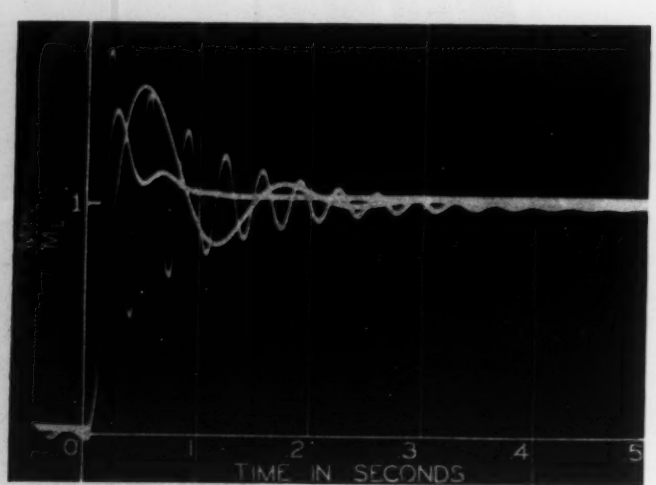


Fig. 27—Other conditions as in Fig. 24, M_m/M_L shown results from step change in load torque M_L. Compare with curves shown in Fig. 15

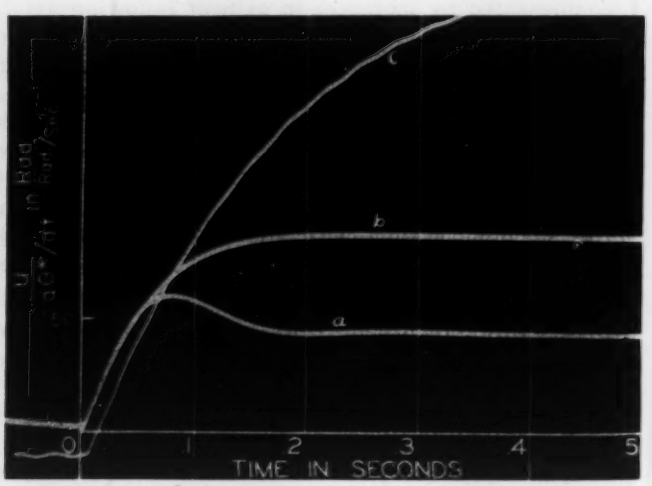


Fig. 28—Deviation resulting from step change on rate of change of desired value θ^*, other conditions as in Fig. 20. Compare with Fig. 18

System constants were fixed at values which existed in the actual system. No tachometric feedback was used. All results are plotted against actual time in the original system and were obtained by photographing the screen of a cathode ray oscillograph. The time required to obtain a single solution not including film processing is approximately two minutes. The gain of 142 was selected to give a maximum amplitude ratio of 1.3 for θ/θ^* when the system is subjected to a sinusoidal disturbance.[8] This value has been widely used as representing optimum performance in the case of position controllers.

Effect Of Step Change In Desired Value

In *Figs.* 12 and 13 are shown positional errors and the required motor torque for a step change in θ^*. *Figs.* 14 and 15 show the corresponding responses in error and required motor torque for a step disturbance in load (M_L). In both instances the critically damped case produces a more desirable required motor torque. In the case of a disturbance in desired value the error response involves no overshoot and approaches a zero value almost as quickly as the so-called optimum. Reference to *Fig.* 14, however, shows the inherent large steady-state error produced by the application of a load. This steady-state error is inversely proportional to the overall gain of the system. A reduction of this error in the ratio of 142/52 is obtained by raising the amplifier gain to 142.

If a step change is made in the rate of change of the desired value θ^* the linear variation of θ^* with time, shown in *Fig.* 16, results. *Fig.* 17 shows the positional response to such a disturbance. The error resulting from this disturbance is shown in *Fig.* 18. Steady state deviations which are inversely proportional to amplifier gain (μ) may be observed. Output motor torque for the runs of *Fig.* 18 are shown in *Fig.* 19. Note the steady-state motor torque required to balance the viscous friction torque.

The influence of velocity feedback is illustrated in *Figs.* 20 to 31. *Fig.* 20 shows decreased oscillation and overshoot with the addition of velocity feedback. The increased oscillation at a higher frequency, which occurs if excessive velocity feedback is used, is also apparent. This high frequency oscillation becomes noticeable just before complete instability of the system is reached. *Fig.* 16 gives corresponding re-

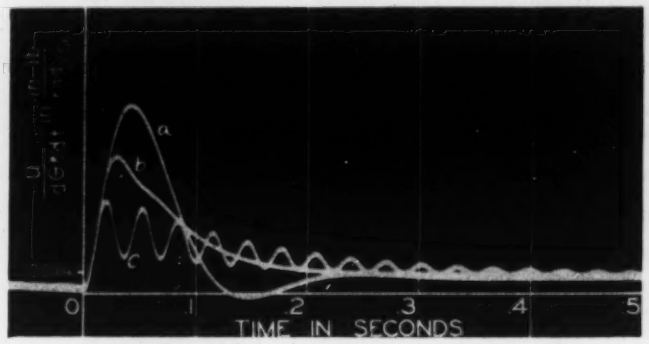


Fig. 29—Manipulated variable M_m resulting from a step change on rate of change of desired value θ^*, other conditions as in Fig. 20. Compare with Fig. 19

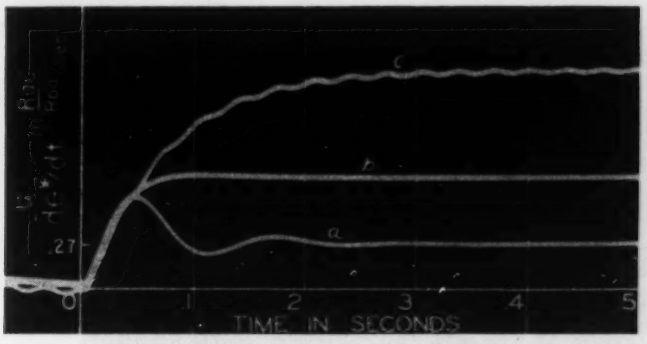


Fig. 30—Deviation resulting from a step change on rate of change of desired value θ^*, other conditions as in Fig. 24. Compare with Fig. 18

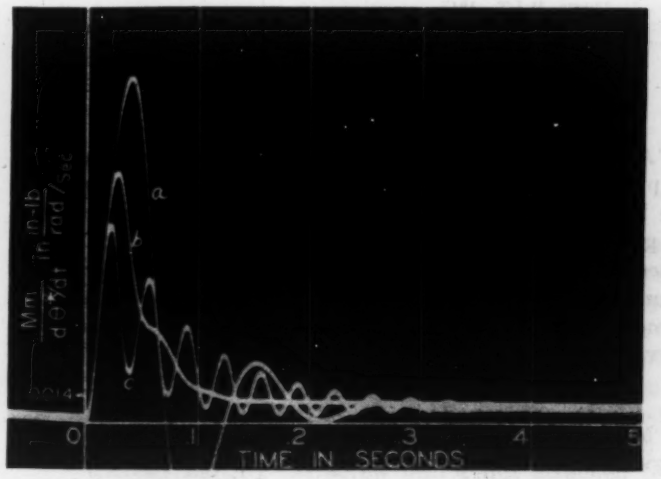


Fig. 31—Manipulated variable M_m resulting from a step change on rate of change of desired value θ^*, other conditions as in Fig. 24. Compare with Fig. 19

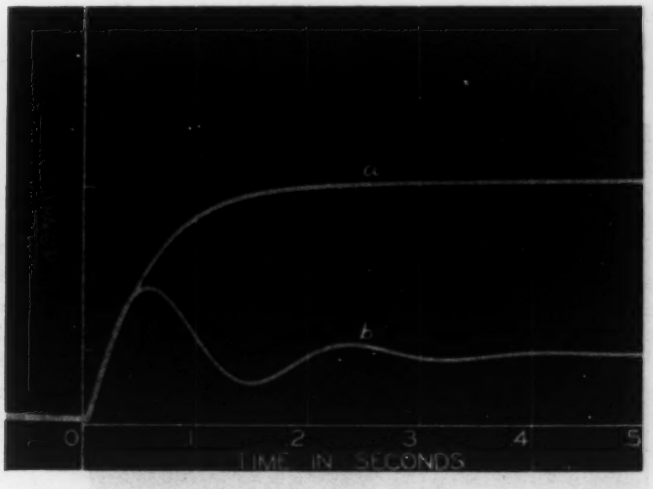


Fig. 32—Conditions as in Fig. 28 but with (a) no condenser in feedback loop and (b) condenser used to reduce velocity steady-state positional error

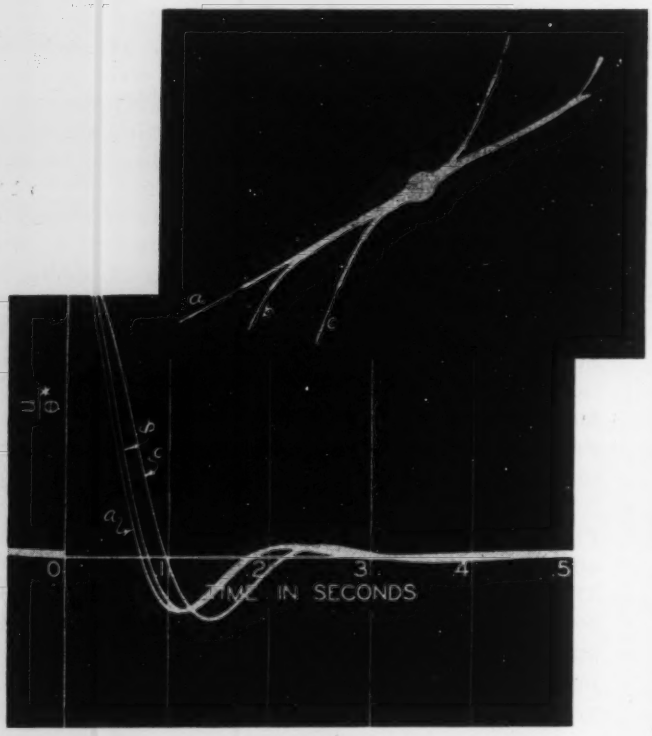


Fig. 34—Above—Effect of nonlinear motor characteristics of Fig. 33 on deviation conditions

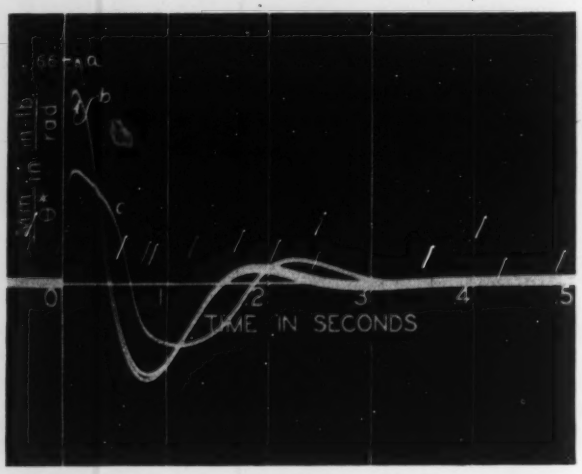


Fig. 35—Above—Same as Fig. 13 but with amplifier gain of 142, no tachometric feedback. Nonlinear motor characteristics of Fig. 33 present at (b) and (c)

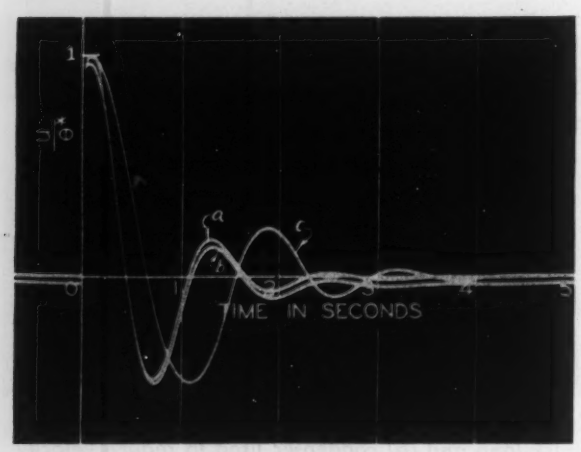


Fig. 36—Above—Same as Fig. 34 with amplifier gain of 260. Compare with Fig. 12

Fig. 33—Left—Armature current versus motor torque for (a) linear, (b) small amount of saturation and (c) large amount of saturation

sults for the highest amplifier gain used. The addition of the proper amount of velocity feedback makes possible the use of a higher amplifier gain, results in non-oscillatory response, and lower steady-state errors due to load torque, *Figs.* 22, 23, 26 and 30. *Figs.* 21 and 25 show the undesirable increase in steady-state velocity error due to the addition of velocity feedback. This can be eliminated by the use of a filter circuit which feeds back only the variable component of the output velocity. *Fig.* 32 illustrates the influence of such a filter circuit.

NON-LINEAR MOTOR CHARACTERISTICS: The foregoing results are based on a linear relation of motor torque to motor armature current. If the nonlinear relationships shown in *Fig.* 33 are introduced, the results shown in *Fig.* 34 to 36 are obtained.

Since one of the great benefits of analogues of this type is the ability to represent pictorially a system performance under widely varying conditions, a large number of photographs have been included in the belief that they will tell their story with greater clarity and conciseness than written descriptions.

ACKNOWLEDGEMENT: The authors acknowledge the valuable assistance and encouragement of G. A. Philbrick.

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"A good football coach would not think of trying to produce a winning team by turning eleven men on the field without any training and only the comment to go out and prove how good they are. Yet that, essentially, is what many firms are doing with their young recruits who, some day, will be expected to assume positions of responsibility"—J. C. MCKEON and GUY KLEIS, *Westinghouse Electric Corp.*

"Management owes a deep obligation to the young engineer who entrusts his education, his economic well-being, his status, much of his happiness, and his working life to the company with which he decides to link a large share of his fate"—LAWRENCE A. APPLEY, *president, American Management Association.*

ELIMINATING Belt Misalignment

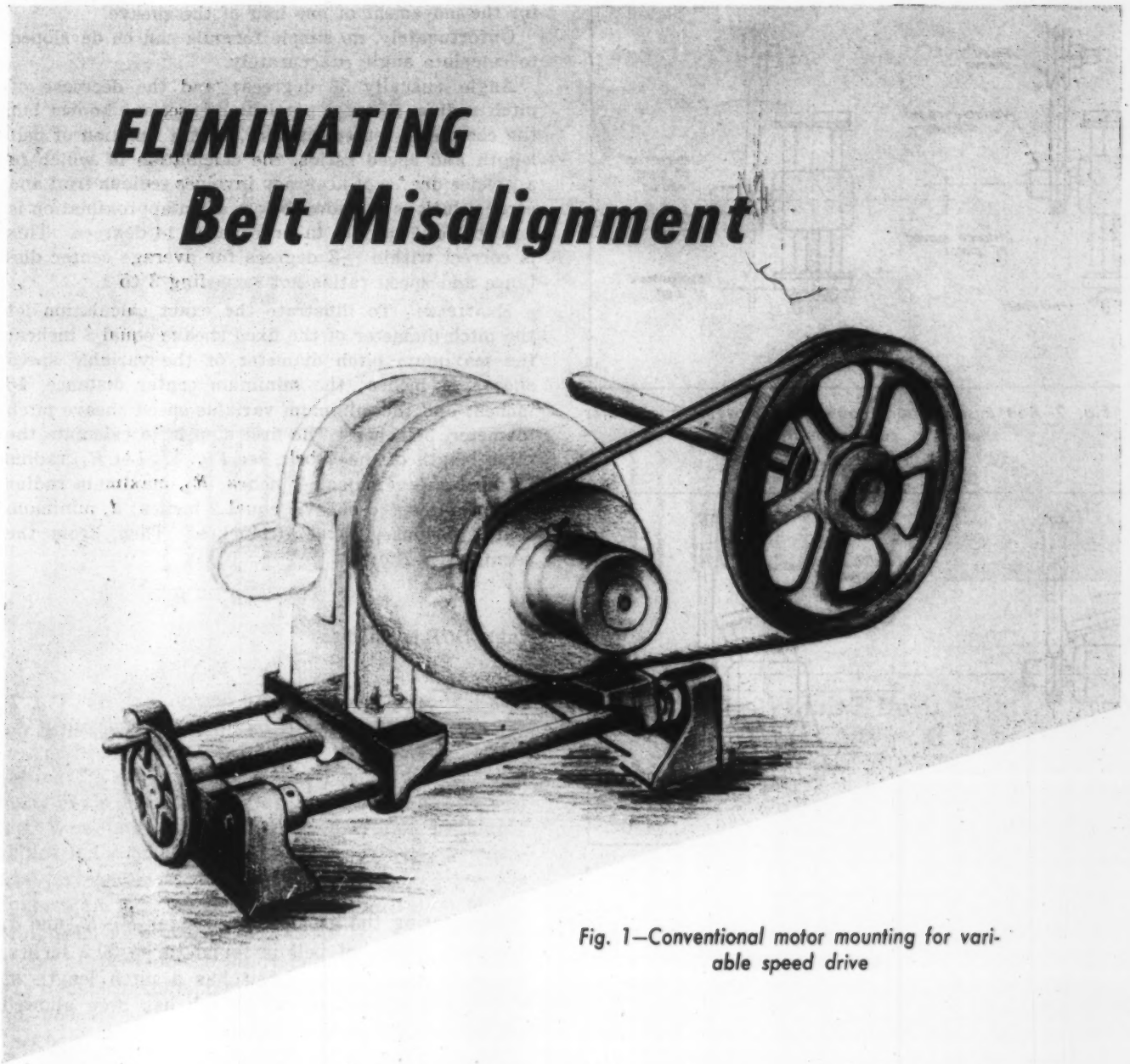

Fig. 1—Conventional motor mounting for variable speed drive

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ILLUSTRATED in *Fig.* 1 is a type of variable speed drive which has become popular as an inexpensive and reliable method of changing machine speeds when using motors up to about 2 hp. Action with the commonly used method of motor mounting is shown in *Fig.* 2. The center distance between the motor shaft and the fixed sheave is increased by turning the handwheel in a clockwise direction and thereby moving the screw into a nut attached to the motor mount. This causes the V-belt to assume a smaller pitch diameter on the variable speed driving sheave by forcing the outer spring-loaded half of the sheave away from the motor into the position shown in *Fig.* 2*b*. The resultant speed of the fixed sheave is considerably less in position 2b than in 2a and any speed between the two extremes may be obtained.

On examining the geometry of *Fig.* 2, it will be noticed that since only one half of the variable speed sheave moves, the center line of the belt moves a distance c which produces misalignment of the belt, causing decrease in belt life and added stress on the bearings. On many applications this factor is overlooked; the remedy, however, is simple.

If b in *Fig.* 2 represents the decrease of pitch radius due to an increase a of the center distance, the misalignment is $c = b\tan\alpha$, where 2α is the included angle of the V-belt groove. If, with an increase a of the center distance, the distance of the motor mount from the belt center line were to increase by

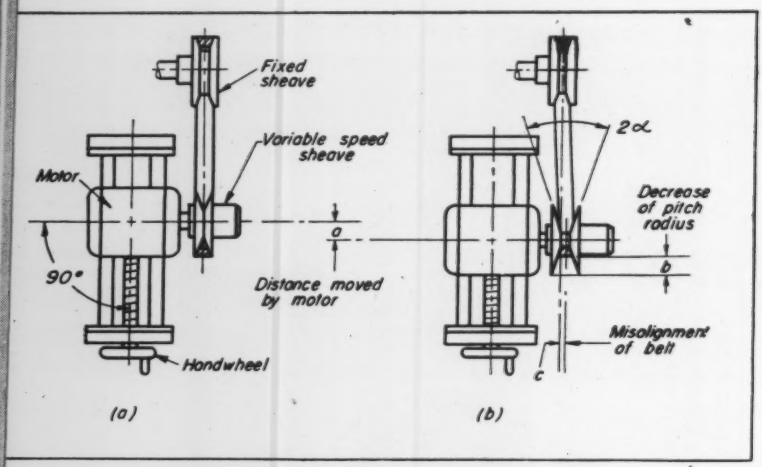

Fig. 2—Belt misalignment caused by movement of outer sheave in conventional mounting

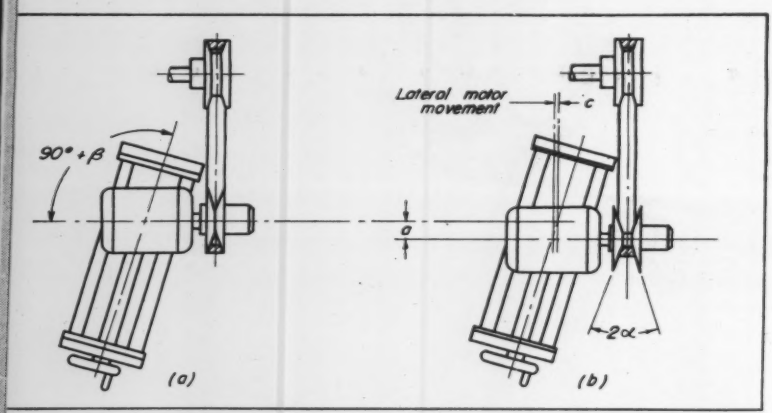

Fig. 3—Method of mounting motor at an angle to eliminate belt misalignment

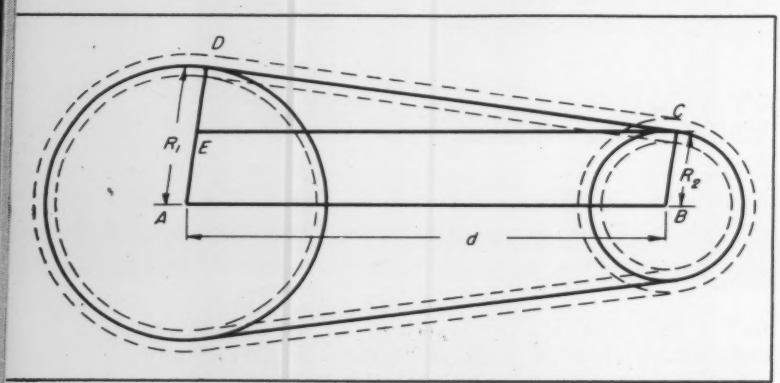

Fig. 4—Geometric presentation of the elements involved in the calculation of mounting angle

$b\tan\alpha$, the belt would remain in a straight line without misalignment.

This can be done, as shown in *Fig.* 3, by mounting the motor on its base at $(90+\beta)$ degrees where

$$\tan\beta = \frac{c}{a} = \frac{b\tan\alpha}{a} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Any change in center distance will now produce a corresponding lateral shift of the motor to compensate for the movement of one half of the sheave.

Unfortunately, no simple formula can be developed to calculate angle β accurately.

Angle (usually 38 degrees) and the decrease of pitch radius, b, for a particular case, are known but the change in center distance, a, is a function of belt length and speed ratios, the calculation of which to a precise degree of accuracy involves tedious trial and error solutions as shown below. If an approximation is acceptable, β may be taken equal to 14 degrees. This is correct within ± 3 degrees for average center distance and speed ratios not exceeding 3 to 1.

EXAMPLE: To illustrate the exact calculation let the pitch diameter of the fixed sheave equal 8 inches; the maximum pitch diameter of the variable speed sheave, 4 inches; the minimum center distance, 16 inches; and the minimum variable speed sheave pitch diameter, 3 inches. The first step is to calculate the pitch length of the V-belt, see *Fig.* 4. Let R_1, radius of fixed sheave, equal 4 inches; R_2, maximum radius of variable speed sheave, equal 2 inches; d, minimum center distance, equal 16 inches. Then, from the geometry in *Fig.* 4,

$$DC = \sqrt{d^2 - (R_1 - R_2)^2}$$

Angle DCE is equal to

$$\sin^{-1}\left(\frac{R_1 - R_2}{d}\right)$$

and the pitch length of the belt, L, is represented by

$$L = R_1\left[\pi + 2\sin^{-1}\left(\frac{R_1 - R_2}{d}\right)\right] + R_2\left[\pi - 2\sin^{-1}\left(\frac{R_1 - R_2}{d}\right)\right] + 2\sqrt{d^2 - (R_1 - R_2)^2} \qquad \ldots\ldots\ldots\ldots (2)$$

Substituting the assumed values for R_1, R_2 and d, the pitch length of belt is found to be 50.9 inches. The nearest standard V-belt has a pitch length of 50.5 inches. Because belt stretch has been allowed for, the calculated value is acceptable.

The next step is to determine the center distance d for $R_2 = 1.5$, substituting in Equation 2:

$$50.9 = 4\left[3.14 + 2\sin^{-1}\left(\frac{4 - 1.5}{d_1}\right)\right] + 1.5\left[3.14 - 2\sin^{-1}\left(\frac{4 - 1.5}{d_1}\right)\right] + 2\sqrt{d_1^2 - (4 - 1.5)^2}$$

which can be reduced to

$$289 - 84\sin^{-1}\left(\frac{2.5}{d_1}\right) + 6.25 \times \sin^{-1}\left(\frac{2.5}{d_1}\right)^2 - d_1^2 = O$$

By means of trial and error solution, $d_1 = 16.62$. Consequently, in *Figs.* 2 and 3, $a = 16.62\text{-}16 = 0.62$; $b = 2\text{-}1.5 = 0.5$; $\alpha = 19$ degrees. Placing these values into Equation 1:

$$\tan\beta = \frac{b\tan\alpha}{a} = \frac{.5 \times \tan 19^\circ}{.62}$$

The motor must therefore be mounted with an angle of 105½ degrees between the centerline of the motor shaft and the longitudinal motor travel.

CUSTOM-TAILOR YOUR MANUAL CONTROLS

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WITH the advanced state of design today, it is incongruous to find that many machines are ill-suited to the people who operate them. During the recent war, the armed services found that many of their critical devices, while mechanically perfect, were incapable of effective operation by highly skilled individuals. Detailed investigations by industrial psychologists and engineers indicated that the "human factors" in the design and operation of the equipment were overlooked.

The purpose of the study reported in this article was to determine the factors making for optimum control and speed of usage of handwheels, cranks, and crossbars under the condition of application involving single settings of indicators within close tolerance limits. To carry out the purpose of the study, an operation was established and an experimental work station built which permitted an operator to set an indicator to a specific position by turning either a handwheel, crank, or crossbar one complete revolution. Factors held constant were: (1) Contents of the operation and (2) accuracy requirements of the operation. Variables introduced were: (1) Type of control device, i.e., handwheel, crank, or crossbar, (2) size of control device, (3) work load, i.e., frictional torque applied to the shaft of the control device, and (4) location of the control device in relation to the operator, both as to height and angle of the axis of the control device shaft.

Each operator performed the same operation throughout the duration of the experiment with a new variable introduced at the end of each ten repetitions. To perform the operation, the operator attached a contact lead to his ankle after the experimenter adjusted the apparatus for the variable to be tested. Upon a light-flash signal from the experimenter, the operator grasped the handwheel, crank, or crossbar and turned it one revolution, clockwise, watching the indicator dial. When the indicator hand came to rest exactly on the "O" mark, the control device was released. When the operator was satisfied that he had made an accurate setting, he depressed a toggle switch mounted to the left of the dial which indicated that the operation was at an end. This introduced the need for the operator to make a decision as to accuracy and to be satisfied with his decision before ending the operation.

Performances Clocked Automatically

Two records were kept of the operator's performance. A time record was kept by means of two synchronous electric clocks operating through two thyratron circuits closed by the operator. One of the two leads from the circuits was grounded to the control device and the second was attached to the operator's ankle. The potential across the leads was 6 volts. When an operator grasped the control device, both clocks started through the two thyratron circuits. The first clock ceased to operate immediately when the operator released the control device. The second clock was stopped by the toggle switch actuated by the operator after the control device was released. The observer recorded the time from each clock and

This article is based on a paper presented at the recent semiannual meeting of ASME in San Francisco.

then turned on a signal light indicating that the next trial could commence.

A graphic record was also kept by a pen attached to the shaft turning the indicator hand. A second pen, mounted in a stationary position, marked dead-center point of the indicator hand. Both pens recorded on a kymograph which moved a paper tape at a constant rate of speed. The graphic record provided information on smoothness of movement, under or over-shooting of the dead-center position, and on hunting or bracketing practices of the operator. This record was periodically examined to insure that the operator was not biased in his decisions as to the accuracy of his work. The operation was under the experimenter's observation as well.

Results are presented in TABLES I and II. In all cases they are the mean of the last five of the ten trials run with each variable for each operator. Original data were plotted for each location position, height, and size and type of control device. Variations of each trial for each operator about the grand mean plot for each set of conditons fell within 2σ limits, indicating that the data collected for each subject were "in control".

For all of the operators, working the handwheels at a height of 24 inches off the floor necessitated stooping over. Excluding the smallest wheel size (3 inches diameter), the divergence point, at which there is no significant difference between the sizes, is 40 inch-pounds of frictional torque. With torques smaller than this, the larger the wheel size the poorer the performance, while with torques larger than this, the larger the wheel size the better the performance. The larger the torque, the larger the difference becomes in favor of the larger wheel size. In general, the performance of all the sizes except the 6-inch diameter size is comparable to that turned in at the 36-inch height for the same operating position.

Cranks Better Than Handwheels at 36 Inches

A height of 36 inches may be said to be the one most representative of actual control-device location on standard machine tools. For comparable sizes and torques, cranks give a better performance than handwheels at this height. While the differentials between sizes are smaller, there is no pronounced divergence point. However, a leveling-off takes place at the 60 inch-pound torque for the handwheels and at the 40 inch-pound torque for the cranks. Differences in performance between the various sizes is not as pronounced for the torques below the leveling-off points. In general, above 40 inch-pounds of torque there appears to be a correlation between size and torque.

Another operating condition tested also placed the handwheels 36-inches from the floor with a horizontal axis of rotation, but with the operator standing at right angles to the axis of rotation. The divergence point, while not pronounced, is at the 10 inch-pound torque. For torques above this point, the larger the wheel, the better the operating results and, the larger the differences in performance become in favor of the larger-sized wheels. In general, the performance in this operating position is poorer than when the operators stand facing the control devices.

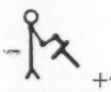
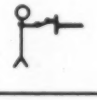
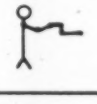
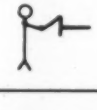
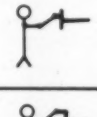
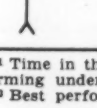
A divergence point at 40 inch-pounds shows up in tests where the handwheels, cranks, and crossbars are 42 inches from the floor with axes of rotation 45 degrees above horizontal. At the largest torque, 90 inch-pounds, cranks turn in a better performance than handwheels. Again, there is a positive correlation between size of control device and frictional torque above the divergence point for optimum performance. Below this point the correlation is negative between size of device and torque for optimum performance. There seems to be no essential difference in performance between cranks and crossbars. There is a closer dispersion in performance between the sizes than noted with the other conditions so far reported. Performance with cranks is slightly better than with wheels of comparable sizes at higher torques. In general, the performance in this operating position is better with the small wheels 3-inch diameter and 6-inch diameter) but is the same with the other devices tested as compared to the 36-inch height.

The divergence point is again at 40 inch-pounds torque when the control devices are located 40 inches off the floor with the axes of rotation 45 degrees below horizontal. A comparable performance is turned in by both handwheels and cranks size for size, while crossbar performance is poorer than both wheels and cranks for comparable sizes. There is a close dispersion in performance between the sizes of control devices. In general, the performance in this operating position is better with the small wheels (3-inch for the other devices as compared to the 36-inch height.

With control devices 39-inches from the floor and rotational axes vertical, the divergence points are at 40 inch-pounds torque for cranks and at 20 inch-pounds torque for wheels. Except for the 10-inch diameter wheel compared to the $4\frac{1}{2}$-inch radius crank, comparable performances are achieved with the same sizes of cranks and wheels. Comparable performances are given with the wheels in this 39-inch location and with them in the 36-inch height, horizontal-axis location. A poorer performance is given with the cranks when comparing these two locations.

Results obtained with the control devices operating 48 inches from the floor also indicate the divergence point is at 40 inch-pounds. Crossbars give a poorer performance than cranks of comparable size, and cranks turn in a better performance than handwheels of comparable size. Cranks at the 36-inch height give a performance comparable to those at the 48-

TABLE I—Performance Times of All Control Tests

Operating Position	Height Above Floor (inches)	Type of Control	Torque (in-lb)	Size of Control: 3" D Wheel or 1½" R Crank		6" D Wheel or 2½" R Crank		8" D Wheel or 3½" R Crank		10" D Wheel or 4½" R Crank		16" D Wheel or 7½" R Crank	
				Time[1]	%[2]	Time	%	Time	%	Time	%	Time	%
0°	24	Wheel	0	20	105	19	100	21	110	25	132	..	...
			20	26	137	19[3]	100	22[3]	116	24[3]	126	..	...
			40	45	196	24	104	24	104	23	100	..	...
			90	..	...	39	139	34	122	28	100	..	...
0°	36	Wheel	0	21	100	21	100	22	105	24	114	22	105
			20	32	152	25	119	23	110	21	100	22[3]	105
			40	52	236	29	132	24	109	22	100	22	100
			60	..	...	34	148	25	109	23	100	23[3]	100
			90	..	...	42	175	32	133	30	125	24	100
L	36	Wheel	0	22	105	21	100	23	110	22	105	..	...
			20	29	145	24	120	22	110	20	100	..	...
			40	51	232	30	136	25	114	22	100	..	...
			90	..	...	52	168	38	122	31	100	..	...
0°	36	Crank	0	18	103	17	100	18	103	18	103	20	118
			20	27	142	19	100	19	100	19[3]	100	20[3]	105
			40	46	230	22	105	22	105	20	100	20	100
			90	..	...	31	141	27	123	22	100	23	104
90°	39	Wheel	0	19	100	19	100	22	116	20	105	21	110
			20	29	152	21	110	21	110	19	100	21	110
			40	45	214	30	143	23	105	21	100	21	100
			60	..	...	37	161	28	117	25	109	23	100
			90	..	...	44	169	38	146	32	123	26	100
90°	39	Crank	0	21	110	19	100	19	100	20	105	22	116
			20	30	150	21[3]	105	21[3]	105	20[3]	100	22[3]	110
			40	51	243	23	110	23	110	21	100	22	105
			90	..	...	35	146	29	121	25	104	24	100
−45°	40	Wheel	0	20	100	20	100	..	...	22	110	22	110
			20	23	109	21[3]	114	..	...	22[3]	100	22[3]	100
			40	28	133	22	104	..	...	21	100	22	104
			90	..	...	28	122	..	...	23	100	24	104
−45°	40	Crank	0	..	...	19	100	..	...	19	100	20	105
			40	..	...	22	110	..	...	20	100	21	105
			90	..	...	27	123	..	...	23	104	22	100
 +45°	42	Wheel	0	20	105	19	100	..	...	21	110	22	116
			20	23	110	21[3]	100	..	...	21[3]	100	22[3]	105
			40	35	175	22	110	..	...	20	100	22	110
			90	..	...	30	150	..	...	26	100	26	100
+45°	42	Crank	0	..	...	19	100	..	...	19	100	22	116
			40	..	...	21	100	..	...	21	100	22	105
			90	..	...	27	112	..	...	23	100	25	108
 0°	48	Wheel	0	18	100	19	106	20	111	20	111	21	116
			20	23	115	21[3]	105	20[3]	100	20[3]	100	21[3]	105
			40	34	170	22	110	20	100	20	100	21	105
			90	..	...	34	142	29	121	24	100	25	104
 0°	48	Crank	0	18	112	16	100	17	106	17	106	18	112
			20	26	144	19[3]	106	19[3]	106	18[3]	100	19[3]	106
			40	43	226	21	110	21	110	19	100	21	110
			90	..	...	35	159	27	123	23	105	22	100
 0°	48	Cross Bar	0	..	...	..	...	..	...	19	100	21	110
			40	..	...	..	...	..	...	25	114	22	100
			90	..	...	..	...	..	...	26	113	23	100
 0°	58	Wheel	10	21	117	18	100	..	...	21	117	23[3]	128
			20	25	131	19[3]	100	..	...	21[3]	110	23	121
			40	38	173	22	100	..	...	22	100	23	104
			90	..	...	32	123	..	...	26	100	28	108
 0°	58	Crank	10	..	...	20	105	..	...	19	100	22	116
			40	..	...	22	100	..	...	22	100	24	109
			90	..	...	36	144	..	...	25	100	27	108

[1] Time in thousandths of a minute; grand mean of nine operators performing under each set of conditions.

[2] Best performance at each torque = 100 per cent. Higher percentages indicate progressively poorer performances at each torque.

[3] Interpolated.

inch height. With the exception of the 6-inch diameter size, wheels at this height give a performance comparable to that given by them at the 36-inch height.

Lastly, there were tests conducted with the handwheels, cranks and crossbars 58 inches from the floor. As before, the divergence point is at 40 inch-pounds. Cranks and handwheels turn in comparable performances. The 6-inch diameter wheel gives a better performance, while the 16-inch diameter wheel gives a poorer performance at this height than at the 36-inch height. The other wheels are comparable. All sizes of cranks turn in a poorer performance at this height than at the 36-inch height.

TABLE I gives the performance of all operators for all conditions. The performance time is the mean of the mean of the last five trials for each condition for each operator, and is given in thousandths of a minute. For each height, location, type of control device, and torque, the performance of each size of device is related to the best in per cent.

TABLE II gives the optimum sizes of each control device for each set of conditons. The optimum size was determined by best performance in each case. This table is a condensation on the basis of performance of the data furnished in TABLE I.

As has been mentioned, these findings are based upon accomplishing the setting of the control device in one revolution. For settings requiring less than one revolution, particularly those requiring a turn of 90 degrees or less, it can be inferred from experience that handwheels would probably be more effective than cranks. In these cases the operator would probably turn the handwheels using the rim rather than the handle on the wheel.

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They Say...

"Industry's ability to produce and distribute vast amounts of goods has now given it an overwhelming position of influence in the international picture. American business has remained revolutionary through almost two centuries by creating and utilizing the means of production to obtain the greatest and most sustained output of goods the world has ever seen. More important is the fact that American business men have put these goods within the reach of the vast majority of our people"—WILLIAM L. BATT, *president, SKF Industries Inc.*

TABLE II—Optimum Sizes of Control Devices for Each Set of Variables

Height (inches)	Position (degrees)	Type*	Optimum Sizes (inches)			
			0 in-lb Torque	20 in-lb Torque	40 in-lb Torque	90 in-lb Torque
24	0	W	3, 6	6[2]	10	16
36	0	W	3, 6, 8	10, 16[2]	10, 16	16
36	L	W	3, 6	10	10	10
36	0	C	1½, 2½, 3½, 4½	2½, 3½, 4½, 7½[2]	4½, 7½	4½, 7½
39	90	W	3, 6, 10	10	10, 16	16
39	90	C	2½, 3½, 4½	2½, 3½, 4½[2]	4½, 7½	4½, 7½
40	—45	W	3, 6	10, 16[2]	6, 10, 16	10, 16
40	—45	C	2½, 4½, 7½	2½, 4½, 7½	4½, 7½	4½, 7½
42	45	W	3, 6	6, 10[2]	10	10, 16
42	45	C	2½, 4½	2½, 4½	2½, 4½	4½
48	0	W	3, 6	6, 8, 10, 16[2]	8, 10, 16	10, 16
48	0	C	2½, 3½, 4½	2½, 3½, 4½, 7½[2]	4½	4½, 7½
58	0	W	6[1]	6[1]	6[1], 10[1], 16[1]	10[1]
58	0	C	2½[1], 4½[1]		2½[1], 4½[1]	4½[1]

*W=Handwheel; C=Crank.

[1] Optimum sizes at 10 in-lb torque. [2] Based on interpolated data.

Beam Deflections by Matrices

By J. D. Swannack
Chief Design Calculator
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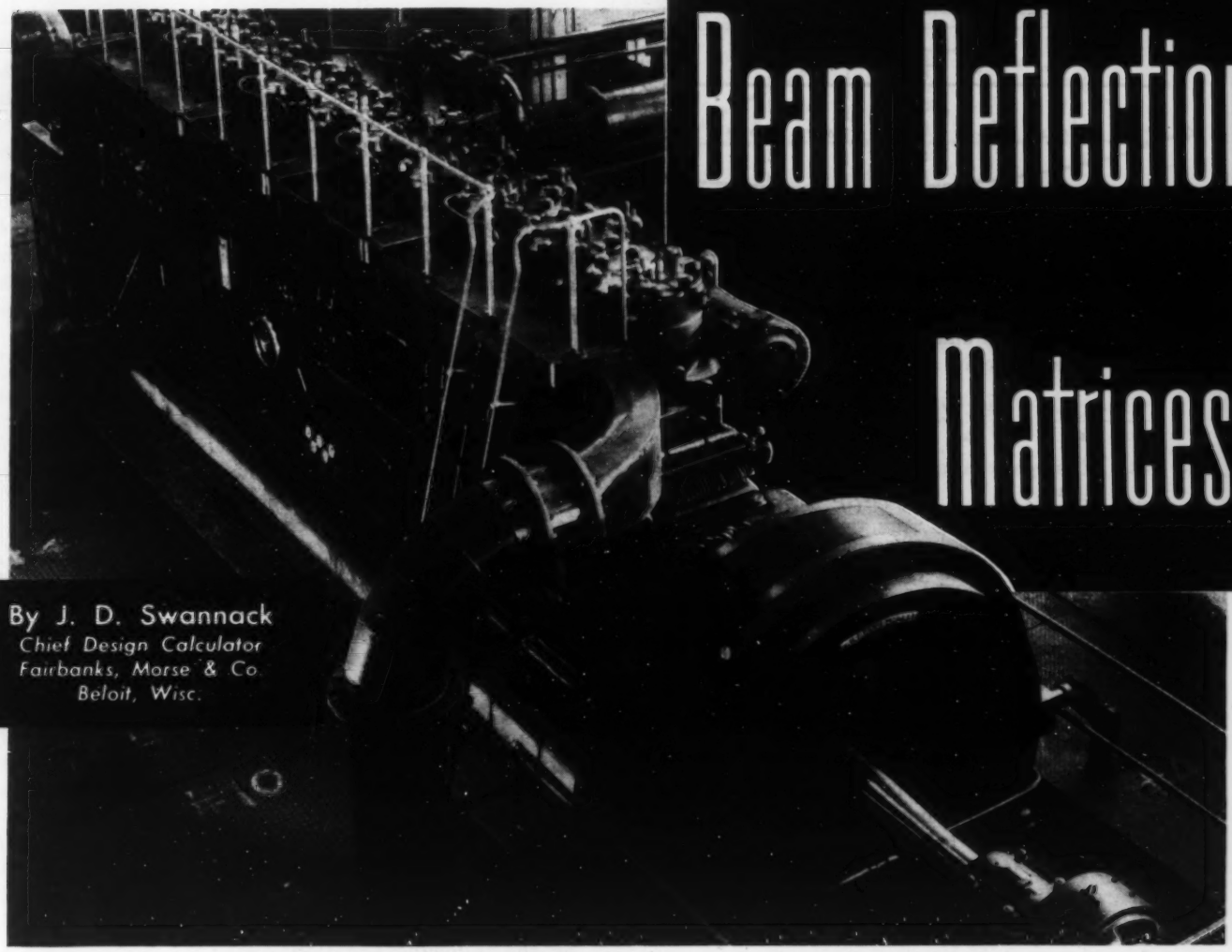


Fig. 1—Diesel engine-generator set. Natural frequency problems in complicated beam structures found in this type of equipment are readily solved with the matrix system

CALCULATION of beam deflections is a recurrent and often tedious necessity in many design problems. A time-saving method, discussed in this article, has been applied to such problems as diesel generator drives, *Fig.* 1, and makes use of simple matrices as a means of solving the sets of simultaneous equations involved. Most of the steps in the following discussion are carried out for explanatory purposes only; once an inverted matrix has been constructed, it need not be done again. A file of inverted matrices can be compiled and, as new problems arise, it is only necessary to calculate a set of M/I quantities and operate on them with the particular row or rows of the matrix.

In calculating beam deflections in the usual manner, it is necessary to integrate the differential equation

$$EI\frac{d^2y}{dx^2} = -M \qquad (1)$$

where

x = Length variable of the beam
y = Beam deflection
M = External moment resisted by the beam (a function of x)
E = Young's Modulus for the beam material (usually not a function of x)
I = Moment of inertia of beam section (sometimes a function of x).

Equation 1 can be rewritten in the form

$$\frac{d^2y}{dx^2} = -\frac{M}{EI}$$

In practical design the quantity M/EI cannot usually be expressed analytically. The moment, M, or the inertia factor, I, or both, and sometimes the modulus, E, vary with x in some complicated manner. However, if the numerical value of M/EI can be found at a sufficient number of locations along the beam it is possible to solve for the deflection at these points by approximate integration procedures.

A numerical attack can be based on finite difference methods. C. L. Brown[1] has described this theory. For convenience it will be restated.

Imagine curve A-B in *Fig.* 2 to be a portion of the deflected center line of a loaded beam. The length

[1] References are listed numerically at the end of the article.

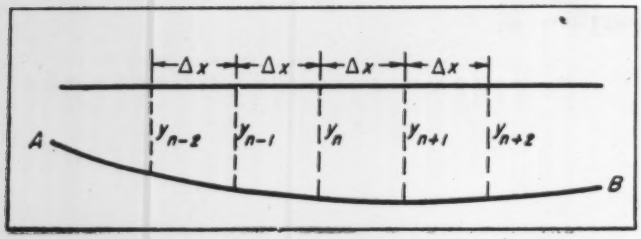


Fig. 2—Sketch of the deflected centerline of a loaded beam divided into a number of small increments

has been divided into small equal increments, Δx. At station n the change in slope will be approximately

$$\frac{(y_{n+1}-y_n)}{\Delta x}-\frac{(y_n-y_{n-1})}{\Delta x}=\frac{(y_{n-1}-2y_n+y_{n+1})}{\Delta x}$$

The rate of slope change will be approximated by

$$\frac{d^2y}{dx^2}=\frac{d}{dx}\left(\frac{dy}{dx}\right)\cong\frac{1}{\Delta x}\,\frac{(y_{n-1}-2y_n+y_{n+1})}{\Delta x}$$

$$\cong\frac{(y_{n-1}-2y_n+y_{n+1})}{\overline{\Delta x^2}}$$

The finite difference equivalent of Equation 1 appropriate to station n can now be written:

$$y_{n-1}-2y_n+y_{n+1}=-\frac{M_n}{E_nI_n}\overline{\Delta x^2} \qquad (2)$$

Values of E_n and I_n are to be taken as the average values in the vicinity of point n.

Consider the simple beam of *Fig.* 3 and suppose $\Delta x = l/4$. Since $y_0 = y_4 = 0$, the following set of difference equations can be written:

$$\left.\begin{aligned}2y_1-y_2&=\frac{l^2}{16E}\,\frac{M_1}{I_1}\\-y_1+2y_2-y_3&=\frac{l^2}{16E}\,\frac{M_2}{I_2}\\-y_2+2y_3&=\frac{l^2}{16E}\,\frac{M_3}{I_3}\end{aligned}\right\} \qquad (3)$$

Insofar as the answer is concerned, Equations 3 can be solved in any expedient manner. The only reason for further concern is that practical beam problems may need ten or twelve or more equations for acceptable accuracy. Mr. Brown has shown a simple way of obtaining this solution for a large number of equations. It is especially recommended that the reader consult his article[1].

The present method is an application of a standard matrix solution for simultaneous equations. As yet these methods[2] have not become general.

Preliminary to further discussion, Equation 3 will be rearranged as follows:

$$\begin{bmatrix}2&-1&0\\-1&2&-1\\0&-1&2\end{bmatrix}\begin{bmatrix}y_1\\y_2\\y_3\end{bmatrix}=\begin{bmatrix}\frac{l^2}{16E}\,\frac{M_1}{I_1}\\\frac{l^2}{16E}\,\frac{M_2}{I_2}\\\frac{l^2}{16E}\,\frac{M_3}{I_3}\end{bmatrix} \qquad (4)$$

Now the equation $Ay = h$ where A and h are constants, has the solution $y = h/A$ *or* $A^{-1}h$. The analogy with Equation 4 is evident. In place of the simple constant A the set (matrix) of y coefficients is used. Then y becomes a column (matrix) of y's and h a column (matrix) of constants. If the rules of this kind of algebra are known sets of quantities can be manipulated with a great reduction in labor.

For this solution it is sufficient to know a few matrix multiplication rules and the matrix equivalent of division. The appendix at the end of this article gives a more detailed explanation of the use of matrices.

EXAMPLE: A case of practical importance concerns a large wound rotor induction motor with the rotating system shown in *Fig.* 4. It is necessary to calculate the first natural frequency of lateral vibration for this system to insure that resonance does not occur near line frequency. The simplest approach requires finding the static deflection of the shaft at the rotor due to the rotor weight.

Shaft details and information for this calculation are given in *Fig.* 5. Span between bearings is 48 inches and the computation will be made with 12 equal divisions. First step is the calculation of M and I values. Where the shaft changes section, as at station 1, 3 and 10, it is usually sufficient to take the average of the I values at either side of the point. However, a refinement is possible that is simple and will relieve the anxiety of the calculator somewhat.

Consider *Fig.* 6 to be a short length of beam with two constant sections. It can be shown that the equivalent small length of beam l having constant prismatic section and inertia factor I_e is expressed by the following equation:

$$I_e=\frac{l}{\frac{I_2}{I_1}l_1+l_2}\,I_2 \qquad (5)$$

Use of Equation 5 to calculate equivalent I values at stations 1, 3 and 10 is illustrated as follows:

$I = 17.98$ in.^{4} for the 4⅜-inch diameter
$I = 37.29$ in.^{4} for the 5¼-inch diameter
$I = 87.62$ in.^{4} for the 6½-inch diameter

Therefore

$$I_1=\frac{4}{\frac{37.29}{17.98}\,1.75+2.25}\,37.29=25.37\text{ in.}^4$$

TABLE I—Values of M/I for Shaft in Fig. 5

1 Station	2 M	3 I	4 M/I
0	0		
1	3,083	25.37	121.5
2	6,167	37.29	165.4
3	9,250	47.53	194.6
4	12,333	87.62	140.8
5	15,417	87.62	176.0
6	16,650	87.62	190.0
7	16,033	87.62	183.0
8	15,417	87.62	176.0
9	12,950	87.62	147.8
10	8,633	47.43	182.0
11	4,317	17.98	240.1
12	0		

$$I_3 = \frac{4}{\frac{87.62}{37.29}\,2.5 + 1.5}\,87.62 = 47.53 \text{ in.}^4$$

$$I_{10} = \frac{4}{\frac{87.62}{17.98}\,0.875 + 3.125}\,87.62 = 47.43 \text{ in.}^4$$

Calculation of the M/I quantities given in TABLE I, with the aid of which the complete matrix equation can be constructed, using the scheme developed in the appendix:

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \\ y_7 \\ y_8 \\ y_9 \\ y_{10} \\ y_{11} \end{bmatrix} = \frac{48^2}{12^3 \times 30 \times 10^6} \begin{bmatrix} 11 & 10 & 9 & 8 & 7 & 6 & 5 & 4 & 3 & 2 & 1 \\ 10 & 20 & 18 & 16 & 14 & 12 & 10 & 8 & 6 & 4 & 2 \\ 9 & 18 & 27 & 24 & 21 & 18 & 15 & 12 & 9 & 6 & 3 \\ 8 & 16 & 24 & 32 & 28 & 24 & 20 & 16 & 12 & 8 & 4 \\ 7 & 14 & 21 & 28 & 35 & 30 & 25 & 20 & 15 & 10 & 5 \\ 6 & 12 & 18 & 24 & 30 & 36 & 30 & 24 & 18 & 12 & 6 \\ 5 & 10 & 15 & 20 & 25 & 30 & 35 & 28 & 21 & 14 & 7 \\ 4 & 8 & 12 & 16 & 20 & 24 & 28 & 32 & 24 & 16 & 8 \\ 3 & 6 & 9 & 12 & 15 & 18 & 21 & 24 & 27 & 18 & 9 \\ 2 & 4 & 6 & 8 & 10 & 12 & 14 & 16 & 18 & 20 & 10 \\ 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 \end{bmatrix} \begin{bmatrix} 121.5 \\ 165.4 \\ 194.6 \\ 140.8 \\ 176.0 \\ 190.0 \\ 183.0 \\ 176.0 \\ 147.8 \\ 182.0 \\ 240.1 \end{bmatrix}$$

Numerical procedures for deflections at stations 5, 6, 8 and 9 are set forth in TABLE II, with the following results, E being taken as 30×10^6 psi for steel:

$$y_5 = \frac{48^2}{12^3 \times 30 \times 10^6}\,36{,}390 = 0.00162\text{-inch}$$

$$y_6 = \frac{48^2}{12^3 \times 30 \times 10^6}\,37{,}720 = 0.00168\text{-inch}$$

$$y_8 = \frac{48^2}{12^3 \times 30 \times 10^6}\,33{,}610 = 0.00149\text{-inch}$$

$$y_9 = \frac{48^2}{12^3 \times 30 \times 10^6}\,28{,}350 = 0.00126\text{-inch}$$

The calculations shown in TABLE II need not be written down, since they can be carried out completely on a modern calculating machine.

CANTILEVER BEAMS: A variable cantilever beam with its moment diagram is shown in *Fig.* 7. The first difference equation is

$$y_{-1} - 2y_0 + y_1 = -\frac{\overline{\Delta x}^2}{E}\frac{M_0}{I_0}$$

The boundary conditions are satisfied if $y_{-1} = y_1$

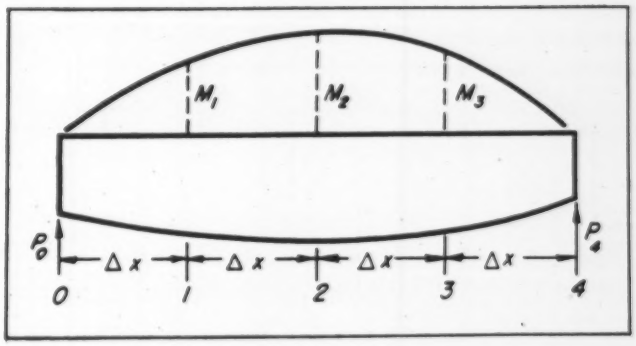


Fig. 3—Moment diagram for beam shown in Fig. 2

and $y_0 = 0$. If $\Delta x = 1/6$, then

$$\left.\begin{aligned} -2y_1 &= \frac{l^2}{36E}\frac{M_0}{I_0} \\ 2y_1 - y_2 &= \frac{l^2}{36E}\frac{M_1}{I_1} \\ -y_1 + 2y_2 - y_3 &= \frac{l^2}{36E}\frac{M_2}{I_2} \\ -y_2 + 2y_3 - y_4 &= \frac{l^2}{36E}\frac{M_3}{I_3} \\ -y_3 + 2y_4 - y_5 &= \frac{l^2}{36E}\frac{M_4}{I_4} \\ -y_4 + 2y_5 - y_6 &= \frac{l^2}{36E}\frac{M_5}{I_5} \end{aligned}\right\} \quad (6)$$

In matrix notation

$$\begin{bmatrix} -2 & 0 & 0 & 0 & 0 & 0 \\ 2 & -1 & 0 & 0 & 0 & 0 \\ -1 & 2 & -1 & 0 & 0 & 0 \\ 0 & -1 & 2 & -1 & 0 & 0 \\ 0 & 0 & -1 & 2 & -1 & 0 \\ 0 & 0 & 0 & -1 & 2 & -1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \end{bmatrix} = \frac{l^2}{36E} \begin{bmatrix} \frac{M_0}{I_0} \\ \frac{M_1}{I_1} \\ \frac{M_2}{I_2} \\ \frac{M_3}{I_3} \\ \frac{M_4}{I_4} \\ \frac{M_5}{I_5} \end{bmatrix} \quad (7)$$

It will be observed that this triangular matrix is in itself equivalent to the solution, since it is pos-

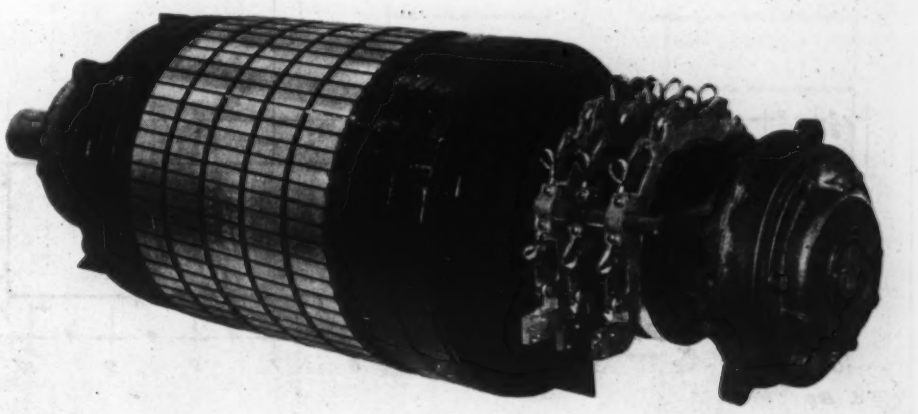


Fig. 4 — Rotating system of wound-rotor induction motor. First natural frequency of lateral vibration must be known to make sure that resonance does not occur near line frequency

sible to solve immediately for y_1 and proceed to solve for the remaining y's in order. However, this matrix has the following simple inversion:

$$A^{-1} = -\tfrac{1}{2}\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 2 & 0 & 0 & 0 & 0 \\ 3 & 4 & 2 & 0 & 0 & 0 \\ 4 & 6 & 4 & 2 & 0 & 0 \\ 5 & 8 & 6 & 4 & 2 & 0 \\ 6 & 10 & 8 & 6 & 4 & 2 \end{bmatrix}$$

The determinant is always equal to ½ and the scheme of constructing the A^{-1} for any order can be readily seen. The solution of Equation 7 is then

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \\ y_4 \\ y_5 \\ y_6 \end{bmatrix} = \frac{l^2}{72E}\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ 2 & 2 & 0 & 0 & 0 & 0 \\ 3 & 4 & 2 & 0 & 0 & 0 \\ 4 & 6 & 4 & 2 & 0 & 0 \\ 5 & 8 & 6 & 4 & 2 & 0 \\ 6 & 10 & 8 & 6 & 4 & 2 \end{bmatrix}\begin{bmatrix} \frac{M_0}{I_0} \\ \frac{M_1}{I_1} \\ \frac{M_2}{I_2} \\ \frac{M_3}{I_3} \\ \frac{M_4}{I_4} \\ \frac{M_5}{I_5} \end{bmatrix} \quad (8)$$

SUMMARY: In calculating deflections of variable section beams M and I values must, of course, be found at a number of points regardless of the method. The matrix solution requires a minimum of numerical work beyond this point.

Since the inverted matrix is known for the cases of the simple and cantilever beams, it is possible to find deflections in a wide variety of nonuniform beam structures.

The matrix method should be regarded as a means of solving sets of simultaneous equations and not as a beam calculation system. It happens in the present instance that the required matrix inversion is easily found and constitutes a useful tool. The idea should be kept in mind, as there are undoubtedly other physical problems that would yield systems of equations well adapted to this form of solution.

Appendix

MATRIX RULES: The product of two square matrices is another square matrix. The scheme is demonstrated by the multiplication of two two-order matrices as follows:

$$\begin{bmatrix} 9 & 2 \\ 1 & 6 \end{bmatrix}\begin{bmatrix} 3 & 6 \\ 5 & 4 \end{bmatrix} = \begin{bmatrix} (9\times3+2\times5) & (9\times6+2\times4) \\ (1\times3+6\times5) & (1\times6+6\times4) \end{bmatrix} = \begin{bmatrix} 37 & 62 \\ 33 & 30 \end{bmatrix}$$

Change of order in multiplication does not necessarily result in the same answer. This can be quickly seen by reversing the foregoing sequence:

$$\begin{bmatrix} 3 & 6 \\ 5 & 4 \end{bmatrix}\begin{bmatrix} 9 & 2 \\ 1 & 6 \end{bmatrix} = \begin{bmatrix} (3\times9+6\times1) & (3\times2+6\times6) \\ (5\times9+4\times1) & (5\times2+4\times6) \end{bmatrix} = \begin{bmatrix} 33 & 42 \\ 49 & 34 \end{bmatrix}$$

Postmultiplication of a square matrix by a column matrix is illustrated in the following example:

$$\begin{bmatrix} 9 & 2 \\ 1 & 6 \end{bmatrix}\begin{bmatrix} 3 \\ 5 \end{bmatrix} = \begin{bmatrix} (9\times3+2\times5) \\ (1\times3+6\times5) \end{bmatrix} = \begin{bmatrix} 37 \\ 33 \end{bmatrix}$$

This process is used in forming Equation 4 of the article, which can now be seen to be:

$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} 2\times y_1 - 1\times y_2 + 0\times y_3 \\ -1\times y_1 + 2\times y_2 - 1\times y_3 \\ 0\times y_1 - 1\times y_2 + 2\times y_3 \end{bmatrix}$$

To accomplish matrix division, multiply both sides of the equation by the inverse, A^{-1}, of one of the matrices. For this purpose it is necessary to have the inverse of the matrix

$$\begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$

The inverse of a matrix can be constructed with the aid of the following four rules:

1. Write the transpose (exchange rows and col-

Fig. 5—Shaft details and dimensions for the induction-motor rotor shown in Fig. 4

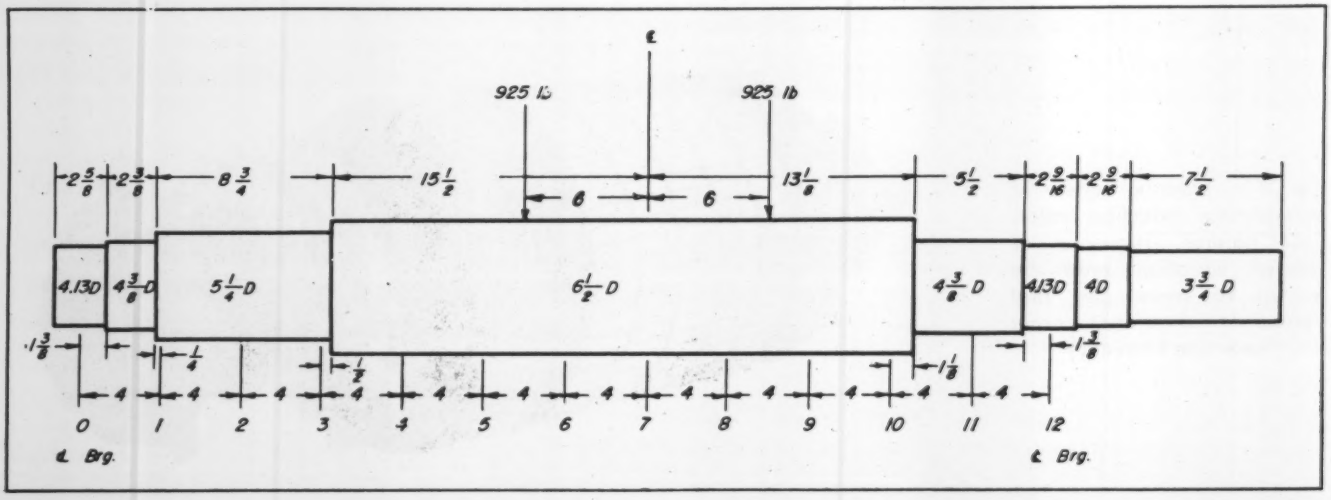


TABLE II—**Tabular Solution for Deflections**

1 Station	2 M/I	3 Row (5)	4 Row (6)	5 Row (8)	6 Row (9)	7 Col. (2) x Col. (3)	8 Col. (2) x Col. (4)	9 Col. (2) x Col. (5)	10 Col. (2) x Col. (6)
1	121.5	7	6	4	3	850	729	486	364
2	165.4	14	12	8	6	2316	1985	1323	992
3	194.6	21	18	12	9	4087	3503	2335	1751
4	140.8	28	24	16	12	3942	3379	2253	1690
5	176.0	35	30	20	15	6160	5280	3520	2640
6	190.0	30	36	24	18	5700	6840	4560	3420
7	183.0	25	30	28	21	4575	5490	5124	3843
8	176.0	20	24	32	24	3520	4224	5632	4224
9	147.8	15	18	24	27	2217	2660	3547	3991
10	182.0	10	12	16	15	1820	2184	2912	3276
11	240.1	5	6	8	9	1200	1441	1921	2161
					Σ	36,390	37,720	33,610	28,350

umns). For example, in the following matrix

$$A = \begin{bmatrix} 1 & 5 & 2 \\ 3 & 2 & 4 \\ 5 & 1 & 6 \end{bmatrix} \quad \text{transpose of } A = \begin{bmatrix} 1 & 3 & 5 \\ 5 & 2 & 1 \\ 2 & 4 & 6 \end{bmatrix}$$

2. Replace each element of the transposed matrix by its minor. Example,

$$\begin{bmatrix} \begin{pmatrix} 2 & 1 \\ 4 & 6 \end{pmatrix} & \begin{pmatrix} 5 & 1 \\ 2 & 6 \end{pmatrix} & \begin{pmatrix} 5 & 2 \\ 2 & 4 \end{pmatrix} \\ \begin{pmatrix} 3 & 5 \\ 4 & 6 \end{pmatrix} & \begin{pmatrix} 1 & 5 \\ 2 & 6 \end{pmatrix} & \begin{pmatrix} 1 & 3 \\ 2 & 4 \end{pmatrix} \\ \begin{pmatrix} 3 & 5 \\ 2 & 1 \end{pmatrix} & \begin{pmatrix} 1 & 5 \\ 5 & 1 \end{pmatrix} & \begin{pmatrix} 1 & 3 \\ 5 & 2 \end{pmatrix} \end{bmatrix} = \begin{bmatrix} 8 & 28 & 16 \\ -2 & -4 & -2 \\ -7 & -24 & -13 \end{bmatrix}$$

3. Divide each element of the matrix obtained from Rule 2, by the determinant of the original matrix. For example, the determinant $A = (A) = 1 \times 2 \times 6 + 3 \times 1 \times 2 + 5 \times 4 \times 5 - 5 \times 2 \times 2 - 1 \times 4 \times 1 - 6 \times 5 \times 3 = 4$. Dividing,

$$\begin{bmatrix} 8 & 28 & 16 \\ -2 & -4 & -2 \\ -7 & -24 & -13 \end{bmatrix}$$

4. Give each element a sign according to the checkerboard arrangement:

$$\begin{bmatrix} + & - & + \\ - & + & - \\ + & - & + \end{bmatrix}$$

Applying this rule to the example,

$$A^{-1} = \tfrac{1}{4} \begin{bmatrix} 8 & -28 & 16 \\ 2 & -4 & 2 \\ -7 & 24 & -13 \end{bmatrix} \quad \text{or} \quad \begin{bmatrix} 2 & -7 & 4 \\ 1/2 & -1 & 1/2 \\ -7/4 & 6 & -13/4 \end{bmatrix}$$

Returning to Equation 4,

$$A = \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix}$$

and it is easy to show that

$$A^{-1} = \tfrac{1}{4} \begin{bmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 3 \end{bmatrix}$$

It can also be verified that

$$A^{-1} = \tfrac{1}{4} \begin{bmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} 2 & -1 & 0 \\ -1 & 2 & -1 \\ 0 & -1 & 2 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$$

and

$$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix}$$

Multiplying Equation 4 by A^{-1},

$$\begin{bmatrix} y_1 \\ y_2 \\ y_3 \end{bmatrix} = \tfrac{1}{4} \begin{bmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} \frac{l^2}{16E} \frac{M_1}{I_1} \\ \frac{l^2}{16E} \frac{M_2}{I_2} \\ \frac{l^2}{16E} \frac{M_3}{I_3} \end{bmatrix} = \frac{l^2}{64E} \begin{bmatrix} 3 & 2 & 1 \\ 2 & 4 & 2 \\ 1 & 2 & 3 \end{bmatrix} \begin{bmatrix} \frac{M_1}{I} \\ \frac{M_2}{I_2} \\ \frac{M_3}{I_3} \end{bmatrix}$$

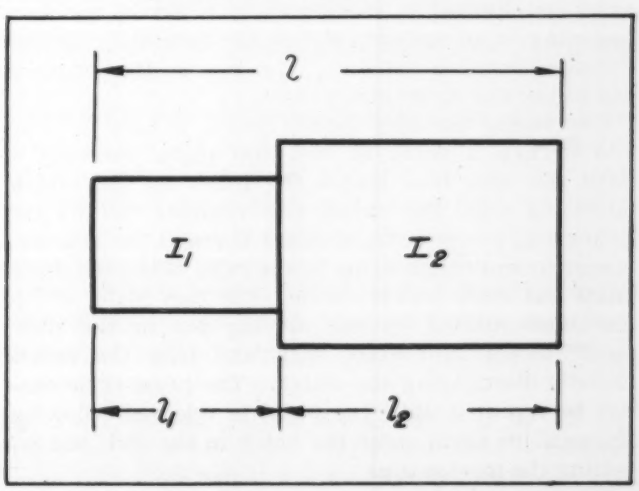
and consequently

$$y_1 = \frac{l^2}{64E}\left(3\frac{M_1}{I_1} + 2\frac{M_2}{I_2} + \frac{M_3}{I_3} \right)$$

$$y_2 = \frac{l^2}{64E}\left(2\frac{M_1}{I_1} + 4\frac{M_2}{I_2} + \frac{M_3}{I_3} \right)$$

$$y_3 = \frac{l^2}{64E}\left(\frac{M_1}{I_1} + 2\frac{M_2}{I_2} + 3\frac{M_3}{I_3} \right)$$

Fig. 6—Diagram for calculating I values for short shafts consisting of two different diameters



Since sufficient accuracy cannot be expected from four divisions, it is necessary to find a simple method of constructing matrices of higher order. By the rules already stated the following inverse matrices of fourth and fifth order can be calculated:

$$A = \begin{bmatrix} 2 & -1 & 0 & 0 \\ -1 & 2 & -1 & 0 \\ 0 & -1 & 2 & -1 \\ 0 & 0 & -1 & 2 \end{bmatrix} \qquad A^{-1} = \frac{1}{5} \begin{bmatrix} 4 & 3 & 2 & 1 \\ 3 & 6 & 4 & 2 \\ 2 & 4 & 6 & 3 \\ 1 & 2 & 3 & 4 \end{bmatrix}$$

$$A = \begin{bmatrix} 2 & -1 & 0 & 0 & 0 \\ -1 & 2 & -1 & 0 & 0 \\ 0 & -1 & 2 & -1 & 0 \\ 0 & 0 & -1 & 2 & -1 \\ 0 & 0 & 0 & -1 & 2 \end{bmatrix} \qquad A^{-1} = \frac{1}{6} \begin{bmatrix} 5 & 4 & 3 & 2 & 1 \\ 4 & 8 & 6 & 4 & 2 \\ 3 & 6 & 9 & 6 & 3 \\ 2 & 4 & 6 & 8 & 4 \\ 1 & 2 & 3 & 4 & 5 \end{bmatrix}$$

The arrangment becomes apparent. The determinant of A is numerically equal to $(n+1)$, where n is the order. The scheme of the outer rows and columns allows them to be written immediately. Each inner element up to and including the diagonal element, is the product of the exterior elements of its row and column. The diagonal is defined to be the line of elements running from the upper left hand to the lower right hand corner.

The beam can now be divided into as many equal parts as desired and the deflection for any or all of these points obtained. This is a very rapid operation with a modern calculating machine.

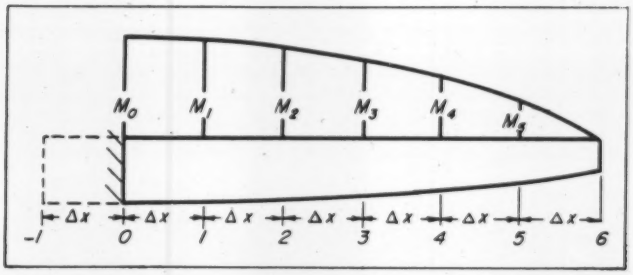


Fig. 7—Diagram representing variable cantilever beam and its corresponding moment diagram

Inversion of a high order matrix is in general extremely laborious. The reader will appreciate this if he has checked the case of the five order matrix given above. Only with certain special matrices is it possible to develop simple rules for inversion.

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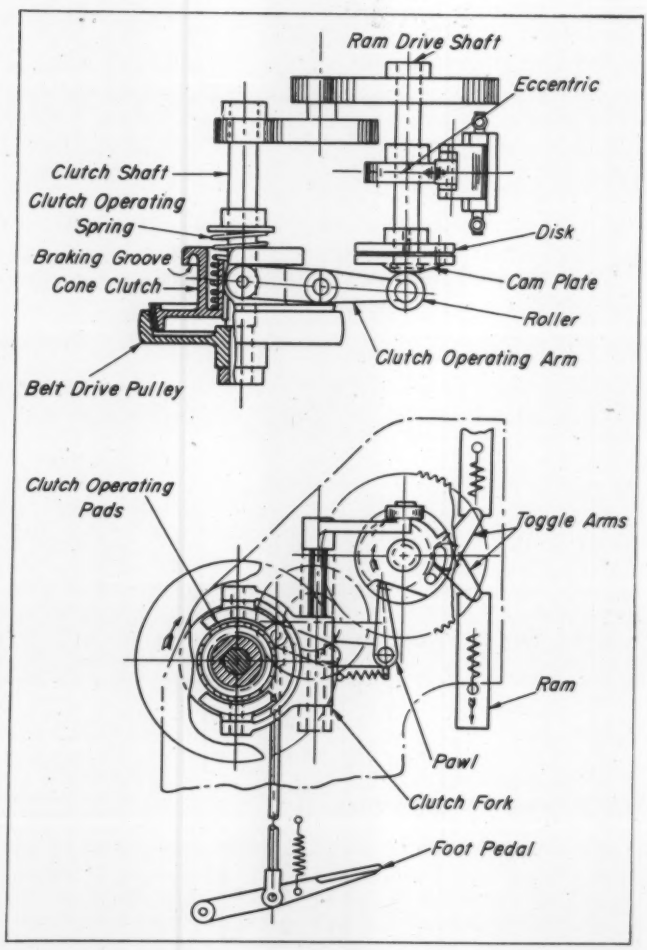
1. C. L. Brown—"Calculating Beam Deflections," MACHINE DESIGN, January 1944, Page 124.
2. A. A. Frazer, W. J. Duncan and A. R. Collar—"Elementary Matrices and Some Applications to Dynamics and Differential Equations", The Macmillan Co., New York, 1947.

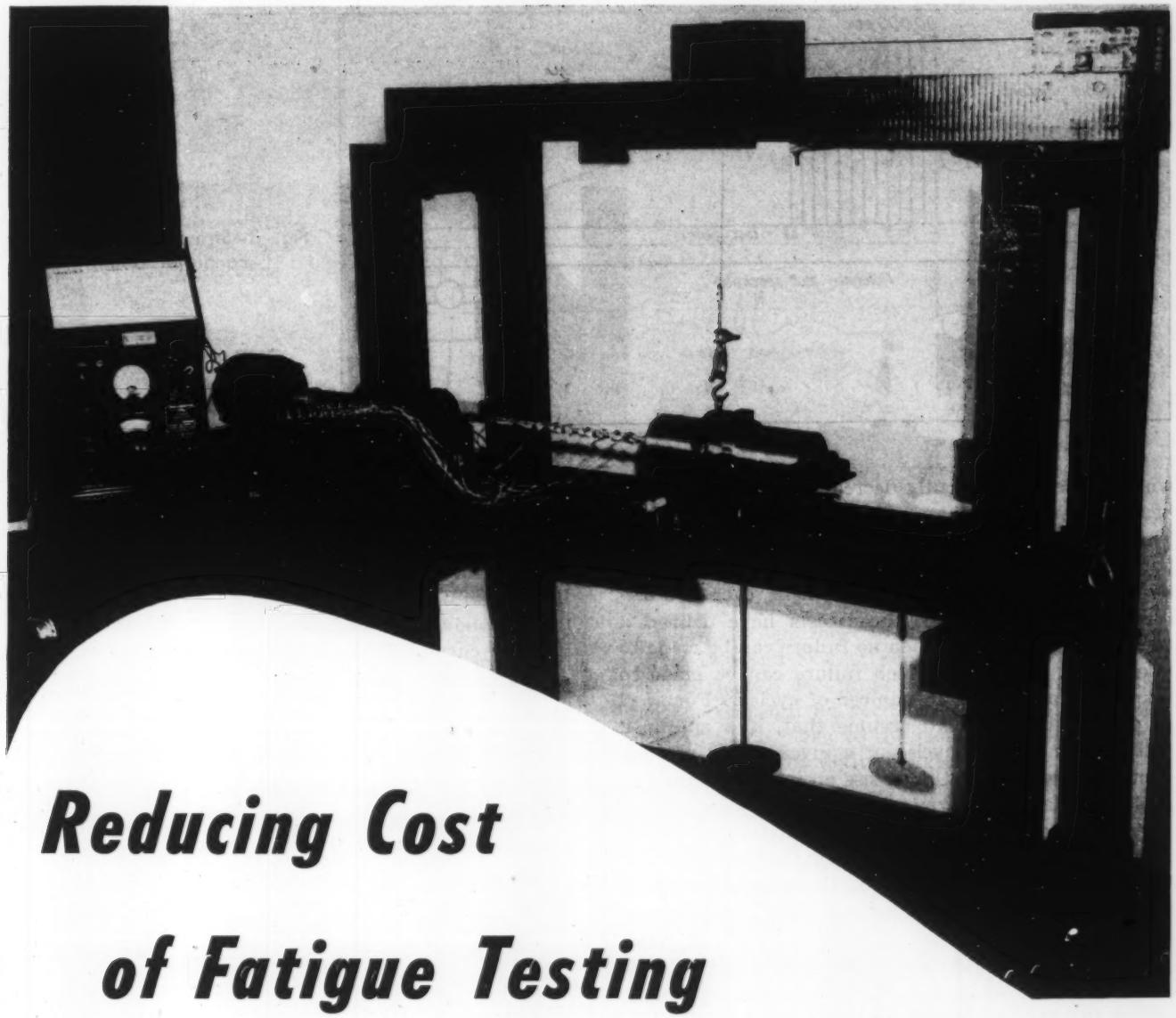
Clutch Prevents Double Stroke

A SINGLE-stroke mechanism described in a previous issue (MACHINE DESIGN, May 1949, Page 146) has prompted David Carlaw (Engineers) Ltd., Glasgow, Scotland, to submit a design used on their window aperture cutting press for making envelopes.

The mechanism is designed to give a single stroke to a press for each depression of a foot pedal. In the event of the foot being accidentally kept on the pedal, the clutch will not re-engage until the foot is lifted and another stroke taken on the foot pedal. Operation is as follows: A belt-driven pulley transmits power through a cone clutch that can slide on a feather key on the clutch shaft. Power from this shaft is taken through reduction gearing to the ram drive shaft. A disk is keyed to one end of the drive shaft and adjacent to it is a cam plate which is free on the shaft but limited in movement by a pin in the disk engaging in an arctuate slot in the cam plate. In the clutch-disengaged position, the pin is the forward end of the slot in the cam plate.

Depressing the foot pedal causes a pawl to rise and engage a notch in the cam plate, rotating it until the cam face leaves the roller on the clutch operating arm. The clutch now engages the driving pulley and power is transmitted through the gearing, eccentric and toggle arms to the ram. When the drive shaft has made one revolution, the cam plate, which has been rotated by the driving pin in the disk, again comes in contact with and lifts the roller, thereby disengaging the clutch. The press cycle cannot be repeated until the pedal is released, allowing the pawl to again enter the notch in the disk and resetting the mechanism.





Reducing Cost of Fatigue Testing

By Hanns J. Maier
Lessells and Associates
Boston, Mass.

ONE of the limitations in the application of fatigue data to design has been the relatively great expense of fatigue tests as compared to that of some of the simpler physical tests. Factors contributing to this expense may be listed as follows:

1. Machining costs due to the fact that a considerable number of specimens is required to determine the fatigue properties of any one material
2. Time required for testing these specimens
3. Cost of testing apparatus.

In order to simplify the method and to reduce costs of obtaining fatigue data, considerable theoretical work has been carried out in an attempt to correlate fatigue strength with some other physical property more readily determined. Until such research results in the development of applicable methods, conventional fatigue testing will continue to be necessary. It is believed that the method discussed in this article will go far toward simplifying and accelerating such testing as well as reducing its cost. The test setup is illustrated in *Fig.* 1.

CONVENTIONAL FATIGUE TESTING: In *Fig.* 2 is shown a conventional fatigue curve together with the experimental points from which it was plotted. As may be seen, a stress appreciably lower than the elastic limit of the material produces failure if applied repeatedly a sufficient number of times. If such alternating stress is made relatively high, it will have to be applied only a few times to cause failure of a test specimen. As the stress is decreased, the number of stress reversals necessary to cause failure increases:

Fig. 1—Accelerated fatigue testing machine set up for calibration by strain gages. Downward force is applied by single weight, upward force by pulleys

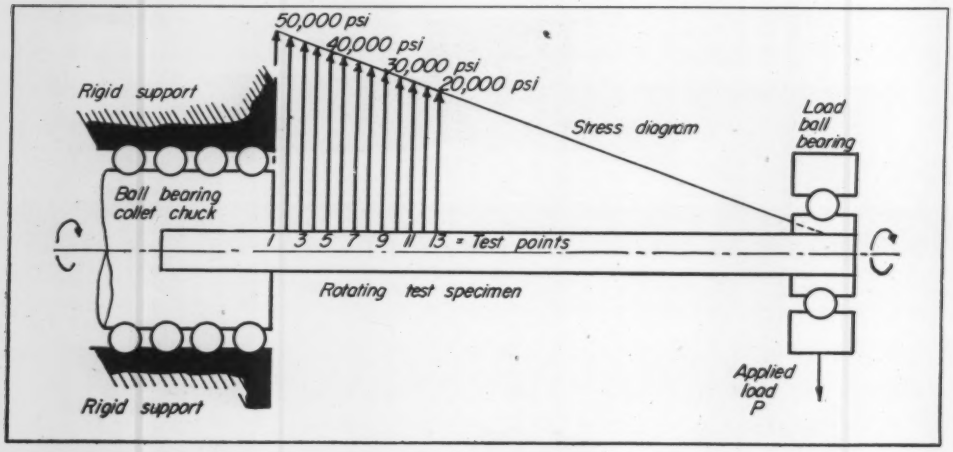
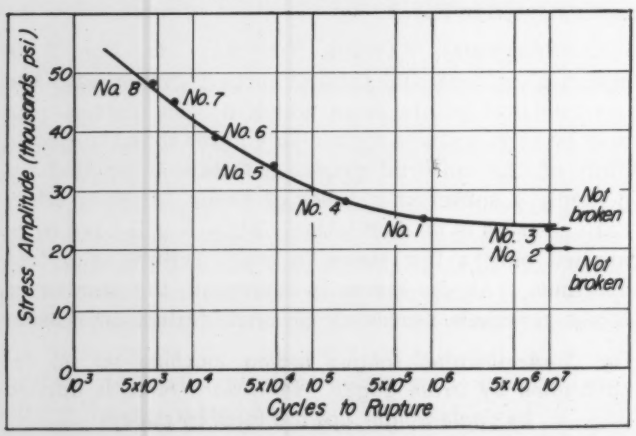


Fig. 3—Stress distribution in cantilever beam

when stress is sufficiently decreased, an infinite number of reversals can be made without causing failure. This stress is termed the *endurance limit*. As is apparent from *Fig.* 2, the endurance limit is obtained by testing a great number of specimens, each at a different stress level, until these tests have defined a range of stress below which no failure can be made to take place, and above which failure can be made to take place after a finite number of cycles. For steel in general it is safe to assume that, if a specimen will run ten million cycles at a given stress without rupture, it will stand this stress an infinite number of cycles. Thus the determination of a complete fatigue curve for a steel involves the accumulation of a finite number of cycles, depending upon the magnitude of the applied stress, on each of the specimens tested at stresses above the endurance limit, and the accumulation of ten million cycles on each of the specimens tested below the endurance limit (marked "not broken" in *Fig.* 2).

For the sake of discusson, it may be assumed that specimen No. 1 of *Fig.* 2 was tested first, No. 2 second, etc. The only information regarding fatigue strength gained by the testing of specimen No. 1 was that the endurance limit lies somewhere below 25,000 psi. Specimen No. 2, tested at 20,000 psi, did not break after ten million cycles, so that on completion of test No. 2 it was evident that the endurance limit fell between 25,000 and 20,000 psi. Narrowing this range further, test No. 3 was carried out at 23,000 psi and also was run ten million cycles without failure. Thus the endurance limit was bracketed between 23,000 and 25,000 psi, say 24,000 psi. Such accuracy was considered sufficient in this case. Further tests, Nos. 4, 5, 6, 7 and 8, were then carried out at stress levels above the endurance limit to complete the fatigue curve. TABLE I shows the number of cycles applied to each specimen.

Fig. 2—Typical fatigue curve for steel



At the conventional fatigue test speed of 3600 cycles per minute eight test points required the machining of eight specimens and a total testing time which is equal to 21,161,200/(3600 × 60) or 98 hours.

TABLE I—Fatigue Test Data

Specimen No.	Cycles to Failure
1	890,000
2	10,000,000
3	10,000,000
4	195,000
5	49,000
6	15,500
7	7,000
8	4,700
Total	21,161,200

ACCELERATED FATIGUE TESTING: The accelerated fatigue testing machine shown in *Fig.* 1 is basically a rotating cantilever beam machine. The static stress distribution in a cantilever specimen of uniform cross section is shown in *Fig.* 3. If the beam is rotated under this static load, it will be subjected to sinusoidally varying bending moments and stresses of amplitudes corresponding to those that can be read off the diagram of *Fig.* 3. Neglecting clamping stresses at the built-in end of the cantilever, it can be seen that the highest stress exists at that point and gradually diminishes as the free, loaded end of the beam is approached. Assuming reasonably small deflections of the beam, it may be stated that the bending moment (and thus the stress) at any one point is entirely independent of what is done to the left of this point, but is a function merely of the load and the distance between the point and the load. As long as these two quantities remain fixed, the stress amplitude will remain fixed.

Assuming that the material being tested is identical with that represented by the curve of *Fig.* 2, the rotating beam will run about 3,600 cycles in the initial position shown in *Fig.* 3, after which failure occurs at

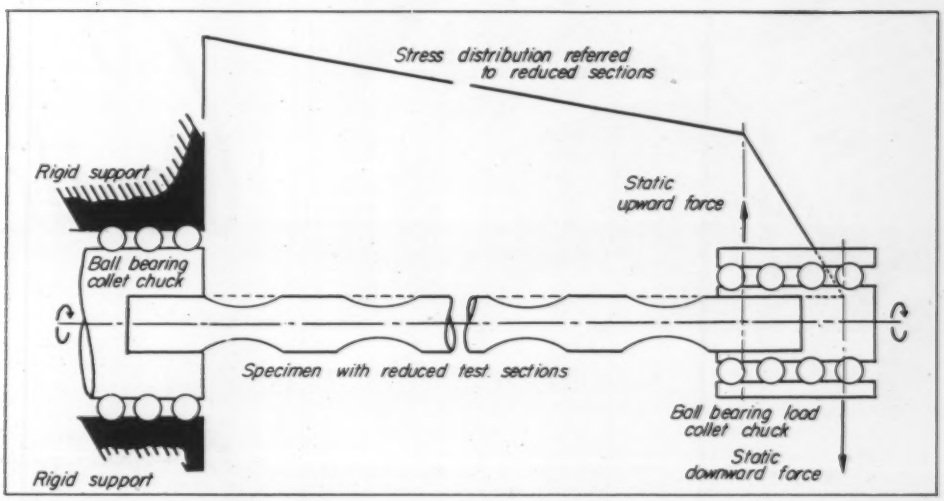


Fig. 4—Details of accelerated fatigue test specimen and method of load application

point (1), the most highly stressed point on the beam. The machine is stopped. The section of the specimen to the left of the fracture is removed from the collet chuck and the fractured surface at (1) is inserted in the chuck, bringing point (2) into the position formerly held by point (1). The test is then permitted to proceed.

It must be noted that at this stage the stress at point (2) has not been altered since no changes have been made to the load or to the distance between the load and point (2). Also point (2) has already undergone 3,600 cycles of stress reversal in the first stage of the test resulting in failure of point (1). From *Fig.* 2, it is apparent that a stress of about 47,500 psi in this material may be withstood 4,750 cycles. Thus, fracture would take place at point (2) after a total running time corresponding to 4,750 cycles. However, of these 4,750 cycles, 3,600 have already been applied during the first stage of the test in order to obtain test point (2), and 1,150 additional cycles are required. This process is repeated until a point on the beam reaches the collet chuck without failing in ten million cycles of total running.

Modifications of Apparatus and Specimens

Experience gained in practical experimentation with this device has resulted in two modifications of design, as indicated in *Fig.* 4: Use of reduced test specimen sections, and of a two-load system.

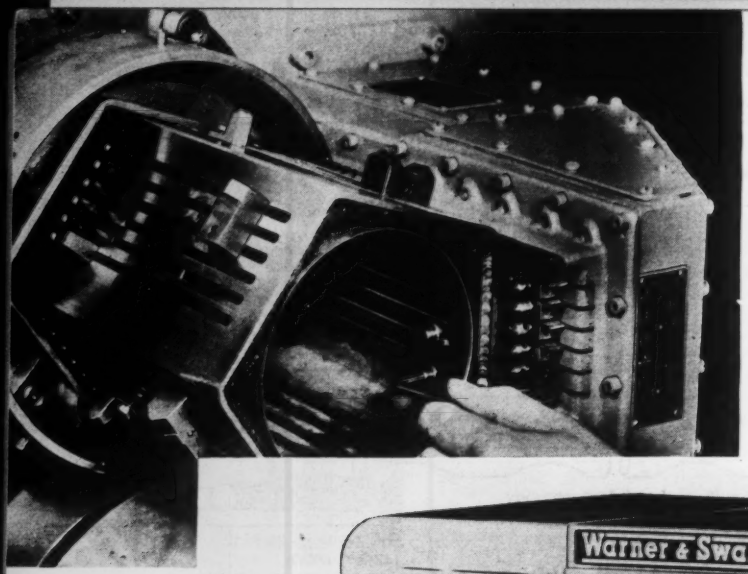
Reduced Test Sections. These were found necessary in order to prevent the specimen from breaking under the jaws of the collet chuck due to the clamping stresses induced at that point. Since all of the test sections have been reduced by the same amount, the bending moment diagram still corresponds to the stress diagram as regards the minimum sections.

Two-Load System. From practical considerations it may be noted that a finite length of specimen must exist between any two test sections in order that the specimen be clamped in the chuck after each fracture. Means had to be devised to keep the change in stress amplitude from one test point to the next sufficiently low to give enough test point for a complete fatigue curve. With a single load cantilever, an extremely long specimen would be required to achieve this end and a great portion of the total length near the point of load application would not serve any useful purpose since the stresses in this section would be below the endurance limit.

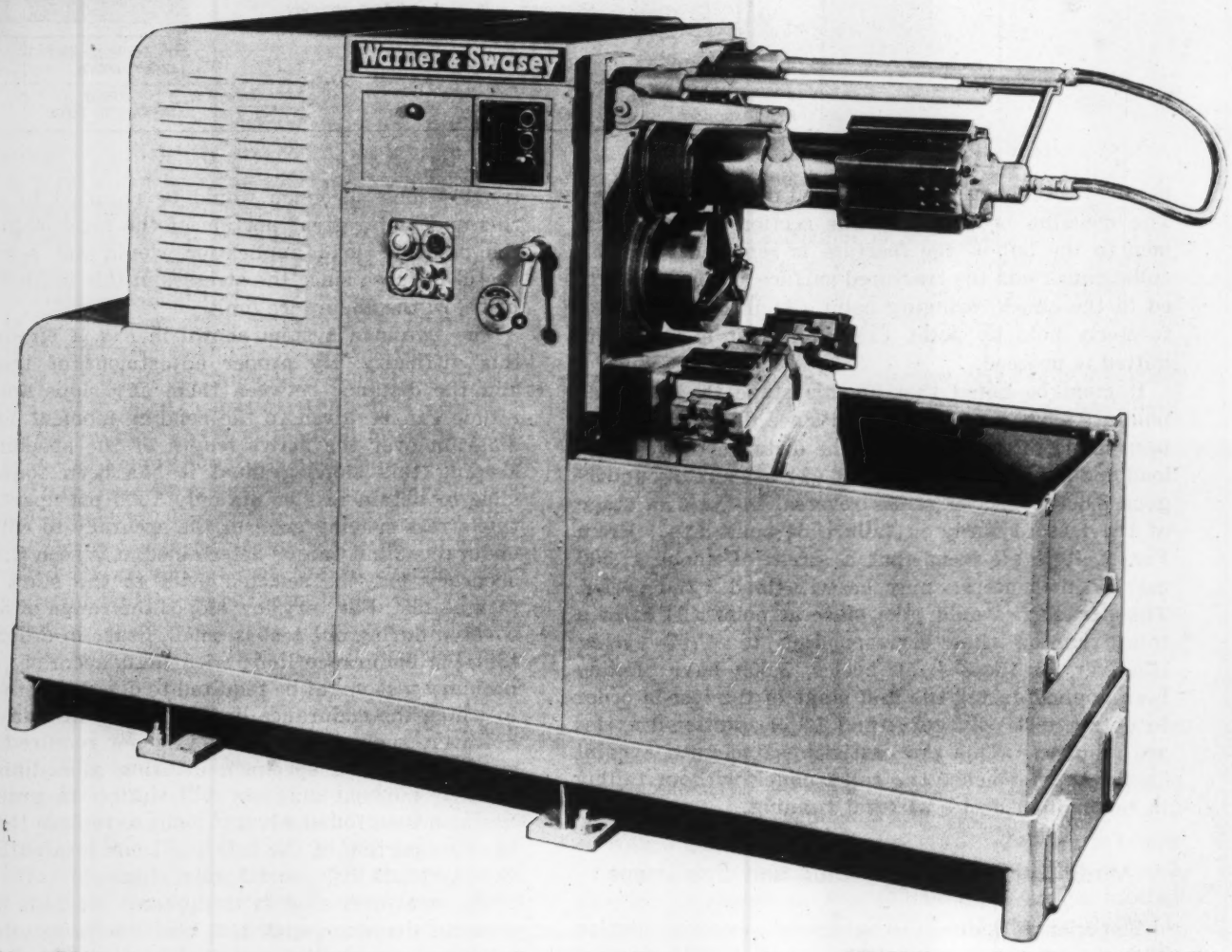
The two-load system shown in *Fig.* 4 circumvents this difficulty. By proper adjustment of the loads and the distance between them any slope and magnitude can be given to the bending moment (stress) diagram over the active length of the specimen. By keeping this slope gradual it has been found possible to obtain test points only 1000 psi apart. Since this stress spacing governs the accuracy to which the endurance limit can be determined, it is seen that such accuracy may be selected prior to the start of the fatigue test. For very low slopes the range of stresses covered during one test is small, hence in order to obtain the endurance limit with high accuracy, a preliminary test might be required to determine the range in which the endurance limit will fall. In many cases, however, such great accuracy is not required, and a single test on a specimen utilizing a medium slope bending moment diagram will suffice. In practice, it has also been found advantageous to replace the outer, inactive portion of the rotating beam located between the two loads by a second collet chuck.

The specimen used in the present machine is ½-in. nominal diameter with test sections ⅜-in. diameter. In practice it will be possible to use specimens of larger diameter. The loads were applied by means of dead weights (the upward load through a system of pulleys) and calculated test stresses were substantiated by strain measurements made with wire strain gages attached to the test section and read while the beam was not rotating, *Fig.* 1. Test results available to date are limited but show the expected correlation with rotating beam fatigue tests carried out in the conventional manner, for SAE 1020 steel.

FUTURE WORK: By means of suitable servomechanisms, counters and recorders, an automatic fatigue testing device may be developed around the principle discussed here, in which the only work required will be the initial assembly and starting of the machine. The apparatus itself would then test and manipulate the specimen and plot automatically the fatigue curve on an output recording potentiometer.



Contemporary

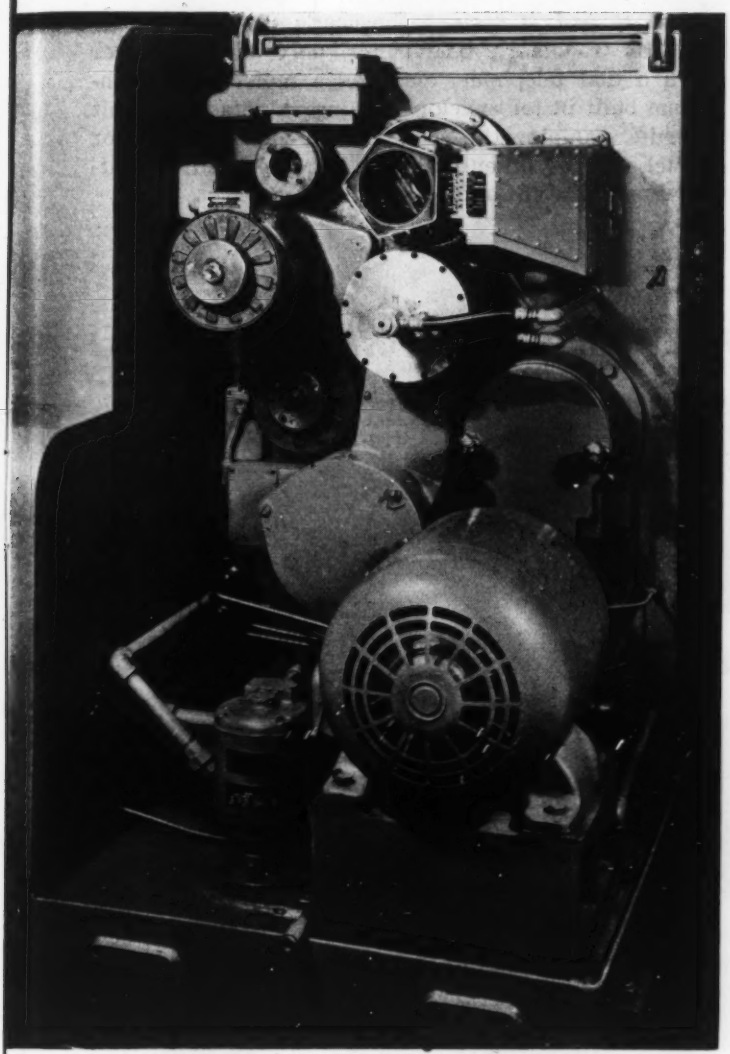


Lathe Design Simplifies Setup

SIMPLE and rapid setup, fast automatic operation and no cam changes permit the use of the 1-AC single spindle automatic chucking machine shown, above, on short run as well as high production jobs. A pentagonal control drum equipped with adjustable trips for the selection of feeds, spindle speeds, length of cutting stroke and skip indexing is the principal design innovation. Permanent cams for both turret and cross slide eliminate time-consuming cam changes when setting up a new job.

Ease of adjustment and accessibility of the trips on the selector drum can be seen in the photograph, upper left. The position of the feed trip controls the stroke and rate of feed; various speed trips determine spindle speed and their position determines the time of speed change. Three feeds are automatically available at any point during the operation and in any order, being selected during setup by changing pickoff gears. Four spindle speeds are provided at any turret face or cross slide in any order. The index drum is shown surrounding the rear section of the selector drum. It controls the operation to be performed on any particular face, the face on

Design



which the automatic cycle starts and stops, skip indexing of turret faces and the selection of cross slide operation, i.e., whether there will be dwell, no dwell or late action of either or both cross slides.

Drive end of head with cover removed, above, showing both cam and turret control drums, limit switch boxes, magnetic brakes and the main drive motor. Spindle is driven through change gears and two solenoid-operated hydraulic clutches to give the four preselected speeds. Magnetic brakes provide for quick stopping of the turret in rapid traverse and another magnetic brake is mounted on the motor driving the turret indexing mechanism. Adjustment of the cam drum controls both the late and dwell cross slide operation by tripping electrical contacts. Manufacturer: Warner & Swasey Co., Cleveland, O.

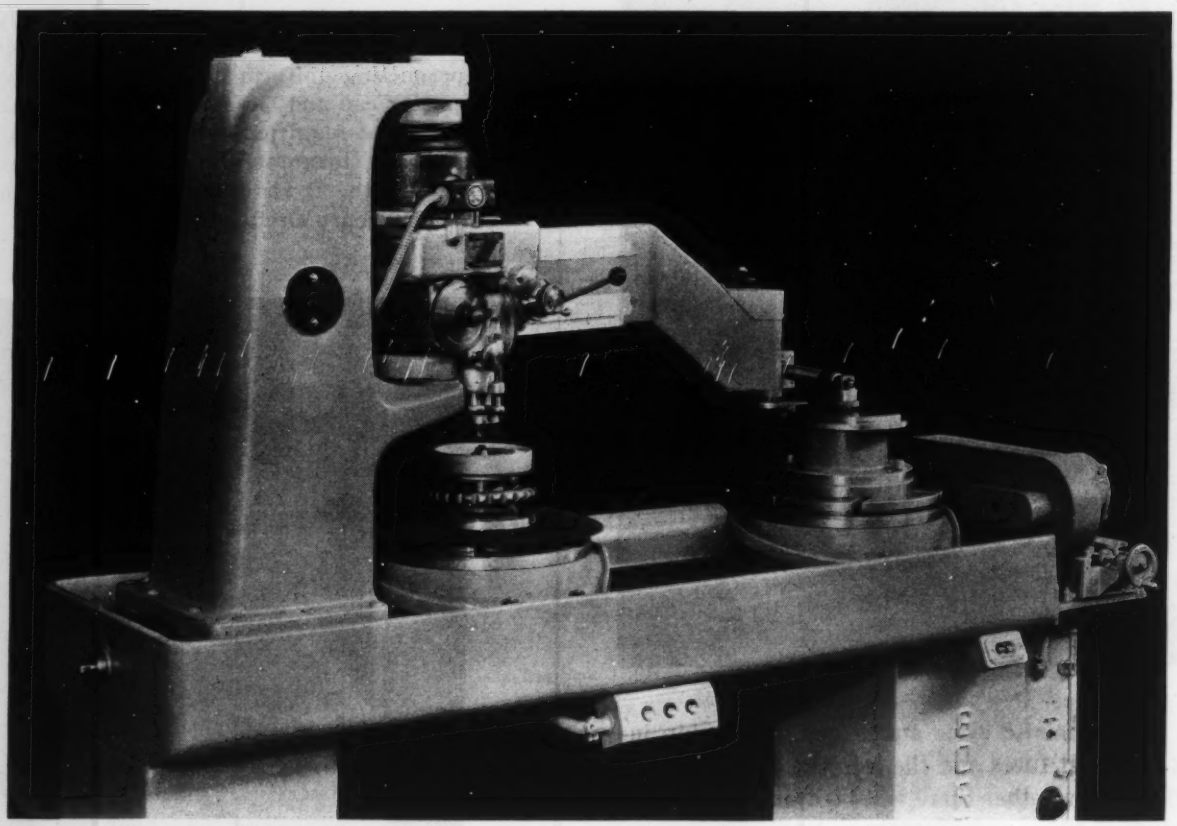
Restyled Pump Has Improved Performance

REDESIGNING a deep well turbine pump for appearance as well as improved performance has resulted in the clean-lined unit shown in the accompanying illustration. Intended for use in irrigation systems, the original model was plagued with lubrication troubles. Because of the wide day to night variation in operating temperatures and as a result of the exposed location of the oil reservoir and drip valve, oil for the moving parts tended to flood during the day and congeal at night. In redesigning the unit, the oil reservoir was placed in the base casting and is kept at a more constant temperature by running the discharge water through it, permitting uniform lubricant flow. Both the top motor cap and base were redesigned as sand castings not requiring added parts or additional cost to the manufacturer. The pump was restyled for the Byron Jackson Co., Los Angeles, Calif., by Henry Drefuss.

Portable Postage Meter

DIALING the stamp value wanted and pressing a lever on this desk model postage meter prints the postage on mail of all sizes and classes. Stamp is a regular metered mail imprint, complete with dated postmark and, if desired, the user's advertising message or trademark. The meter, only slightly larger than a dial telephone, also has a moistening mechanism built in for envelope sealing. A detachable unit permits stamping the postage on a gummed tape for parcel post or other bulky mail. Manufacturer: Pitney-Bowes Inc., Stamford, Conn.

Reduction Assures Accuracy in Cam Profiler



PROFILING and grooving of either the inside or outside periphery of cams to close tolerances and a microinch surface finish is accomplished on the tracer-controlled, swivel-head miller shown in the photograph. Two roller-bearing rotary tables mounted on the machine bed are geared together and powered by an infinitely variable-speed drive unit. Cutter and tracer spindles are secured on a tracer extension arm, workpiece shape being generated by the shape of the master pattern and cutter feed being determined by a tracer-feed cam.

Extreme accuracy of the equipment is possible because of the reduction in size from master to work piece, reduction ratios ranging from 2:1 to 10:1 in five steps. Accuracy is dependent entirely on the accuracy of the tooling and of the master pattern used. Spindle speeds vary from 300 to 10,000 rpm. Containing no complicated or delicate controls, the machine will handle most cam shapes. Manufacturer: George Gorton Machine Co., Racine, Wisc.

Strength and Stiffness of Ribbed Plates

By E. A. Randich
Development Engineer
United Engineering and Foundry Co.
Pittsburgh, Pa.

STIFFENING ribs added to one or both sides of a flat plate loaded in bending may increase or decrease the maximum stress, depending on the proportions. Thus, a slender rib projecting from the plate adds little to the moment of inertia of the section but greatly increases the distance to the extreme fiber, thus actually decreasing the section modulus. The charts presented in this data sheet enable rapid determination of rib proportions and their effect on the strength and stiffness of a plate.

UNRIBBED PLATE: Stiffness of a plate in bending is proportional to the moment of inertia I. For an unribbed plate of width b_o and thickness h_o the moment of inertia is $I_o = b_o h_o^3/12$.

Strength of a plate is proportional to the section modulus, Z, which is the moment of inertia divided by the distance to the extreme fiber. For an unribbed plate $Z_o = I_o/\frac{1}{2}h_o = b_o h_o^2/6$.

PLATE WITH RIBS ON BOTH SIDES: For a ribbed plate such as is shown in *Fig.* 1, the moment of inertia is

$$I = \frac{(b_o - b_r)\, h_o^3 + b_r h^3}{12}$$

Comparing this with an unribbed plate, the *stiffness ratio* is

$$\frac{I}{I_o} = 1 - \frac{b_r}{b_o} + \frac{b_r}{b_o}\left(\frac{h}{h_o}\right)^3 \qquad (1)$$

For the ribbed plate in *Fig.* 1, the section modulus is

$$Z = \frac{(b_o - b_r)\, h_o^3 + b_r h^3}{12 \times 1/2h}$$

Dividing this by the section modulus of the unribbed plate, the *strength ratio* is

$$\frac{Z}{Z_o} = \frac{h_o}{h} - \frac{b_r}{b_o}\frac{h_o}{h} + \frac{b_r}{b_o}\left(\frac{h}{h_o}\right)^2 \qquad (2)$$

It will be noted that $Z/Z_o = (I/I_o) \times (h_o/h)$.

The chart in *Fig.* 1 permits ready solution of Equa-

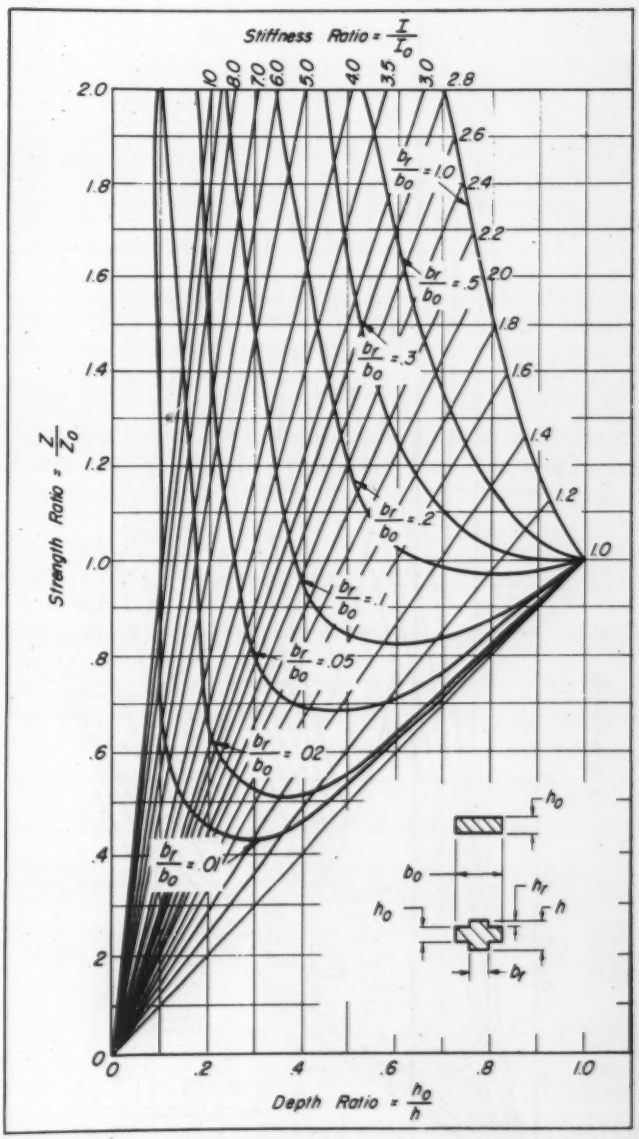


Fig. 1--Strength and stiffness ratios of plates with ribs on both sides. Sketch shows transverse section

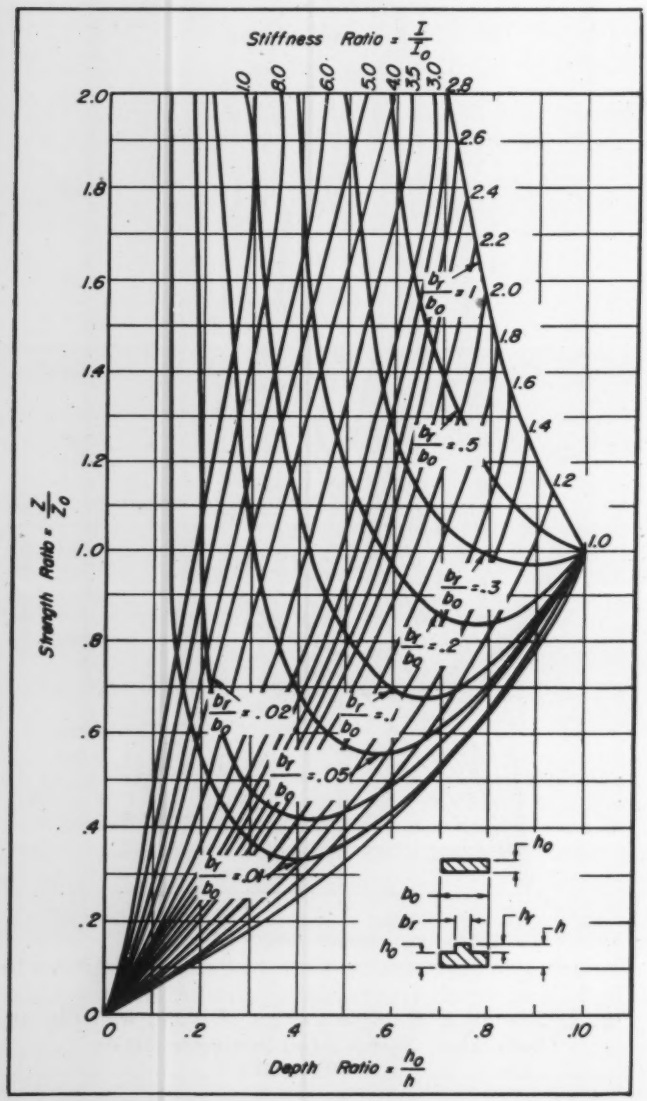
tions 1 and 2 for values of b_r/b_o and h_o/h. The constant stiffness ratio lines (which are straight) give the relation between Z/Z_o and h_o/h for selected values of I/I_o. The constant depth ratio curves give the relation between Z/Z_o and h_o/h for selected values of b_r/b_o.

For multiple ribs, the dimension b_o represents the rib spacing distance.

PLATE WITH RIBS ON ONE SIDE: For a ribbed plate such as is shown in *Fig.* 2, similar equations can be developed. The method is covered in an engineering data sheet "Stiffness of Ribbed Plates" by Joseph Marin, MACHINE DESIGN, May, 1947, Pages 145 and 146. The chart in *Fig.* 2 gives families of curves for determining the ratios I/I_o and Z/Z_o for values of b_r/b_o and h_o/h.

EXAMPLE: It is desired to stiffen a rectangular plate 1 inch thick and 12 inches wide with a series of three ribs spaced 4 inches apart on each side of the plate. In *Fig.* 3 are shown cross sections of the plate and three alternative rib designs. The relative stiffness, strength, and weight ratios are as follows:

Fig. 2—Strength and stiffness ratios of plates with ribs on one side. Sketch shows transverse section



Design	b_r/b_o	h_o/h	I/I_o	Z/Z_o	W/W_o
a	0	1	1	1	1
b	0.0625	0.5	1.44	0.72	1.06
c	0.0625	0.25	4.95	1.24	1.17
d	0.125	0.33	4.25	1.41	1.24

Inspection of these results shows that design *b* having a narrow rib has 44 per cent greater stiffness but 28 per cent less strength than the flat plate. Increasing the height of the rib, design *c*, increases the stiffness ratio to 4.95 and the strength ratio to 1.24. However, design *d* employing a thicker, shorter rib shows almost as high a stiffness ratio (4.25) with the strength ratio increased to 1.41, showing the greater effectiveness of shorter, thicker ribs.

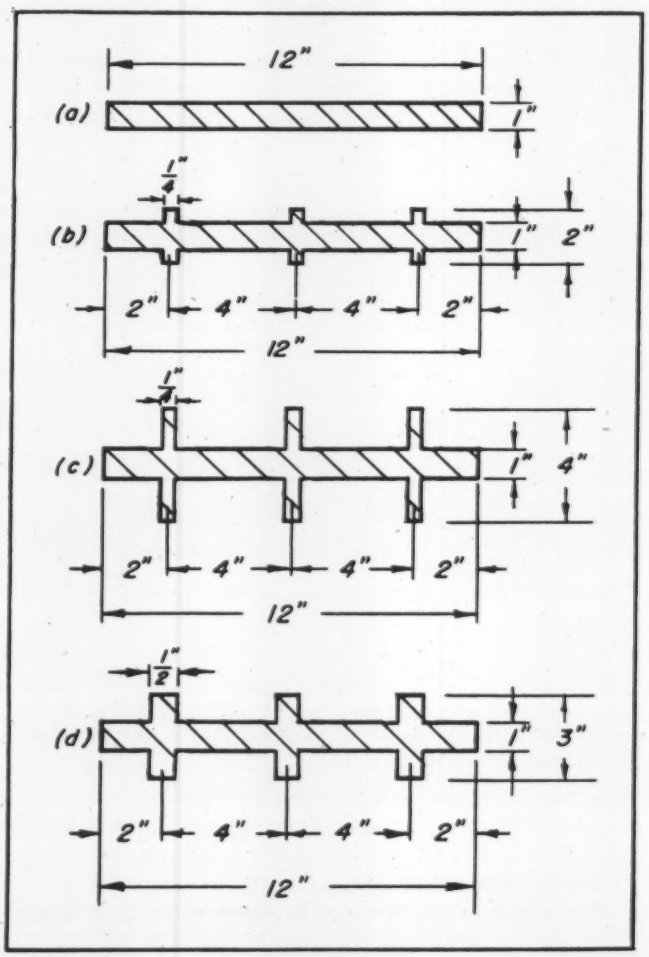
WEIGHT RATIO: If it is desired to compare the weights of the ribbed and unribbed beams it is necessary only to calculate the ratio of cross-sectional areas, which is, for ribs on either one or both sides,

$$\frac{W}{W_o} = \frac{A}{A_o} = \frac{(b_o - b_r)\,h_o + b_r h}{b_o h_o}$$

$$= 1 - \frac{b_r}{b_o} + \frac{b_r}{b_o}\,\frac{h}{h_o} \qquad \text{(3)}$$

The last column in the foregoing tabulation shows the relative weights of the designs discussed in the example.

Fig. 3—Simple unribbed plate (a) and three alternative designs employing ribs on both sides

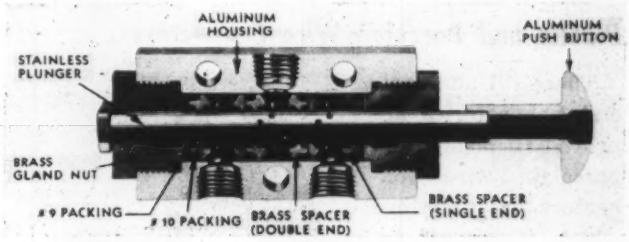


new parts and materials

For additional information on these new developments see Page 159

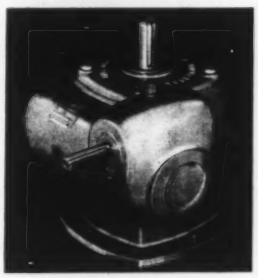
Air & Hydraulic Valves

These small single-plunger series O and OE air and hydraulic control valves are suitable for use with air, oil or water at pressures up to 125 psi, temperatures not exceeding 150 F. Valves are furnished tapped for either ⅛ or ¼-inch pipe connection and can be obtained in two-way, three-way open exhaust, three-way piped exhaust, double two-way, four-way, and five-way designs with either push-pull or push and spring return actions. Type OE valves have open exhaust and should be used with air only. Manufacturer: C. B. Hunt & Son Inc., Salem, O.



For additional information circle MD 1 on Page 159

Double-Reduction Speed Reducer



For vertical applications, model No. VW-2 double-reduction speed reducer has ½-hp input capacity and 1000 lb-in. output torque. However, capacity varies with ratio which has range of from 10:1 to 3840:1. Input shaft is ⅝-inch in diameter and output shaft is 1 inch, although oversize shafts are available. Features include aluminum alloy housings, phosphor bronze gears, 20-degree pressure angle gearing and roller thrust bearings. Manufacturer: Euclid Universal Machine Inc., 15002 Woodworth Rd., Cleveland 10, O.

For additional information circle MD 2 on Page 159

Plastic Laminate

Usable as electrical insulation material for installations where resistance to high temperature is not required, Tensilite 300 high-pressure plastic laminate can be used also for such general construction as wall paneling and trim. Composed of Hycar nitrile-type rubber, virgin pulp paper, phenolic resin and other compounding ingredients, this low-cost material is laminated in conventional manner and can be fabricated by sawing, shaving, drilling and punching, with latter done cold or warm. It is furnished in sheets from 0.0031 to 1 inch thick, in dark brown or black with satin or dull finish. Laminate combines high moisture resistance, flexibility, low heat resistance and low bonding strength. Tensile strength is 15,000 psi lengthwise and 7500 psi crosswise, and flexural strength lengthwise is 22,000 psi as against 17,000 psi crosswise. Other physical properties include ⅛-inch moisture absorption of 1.5 per cent in 24 hours at 25 C, dielectric strength of 600 v per mil short time and 400 v per mil step by step. With compressive strength of 32,000 psi, its power factor at 1,000,000 cycles ranges between 0.045 and 0.050. Manufacturer: B. F. Goodrich Chemical Co., Cleveland, O.

For additional information circle MD 3 on Page 159

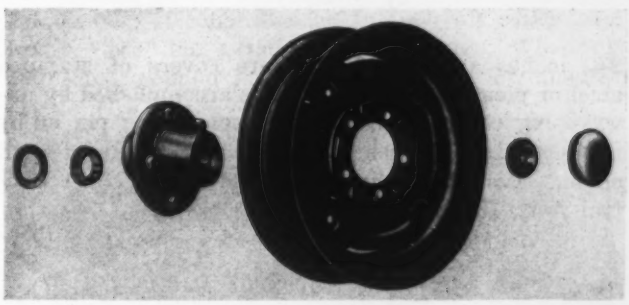
Powder Stainless-Steel Parts

Gears, levers, cams, blocks, gibs, pulleys, ratchets and intricate structural parts difficult to produce economically by machining can be mass-produced from stainless steel powders. Parts have tensile strength of 33,000 psi which is maintained at both high and low temperatures. They can be impregnated with oil if desired, eliminating need for lubricating. Rusting, corrosion and oxidation are eliminated. Manufacturer: Amplex Mfg. Co., 6501 Harper, Detroit 11, Mich.

For additional information circle MD 4 on Page 159

Wheel Assemblies

Usable as mountings for mobile equipment, drop-center disk-wheel assemblies are available in light, medium and heavy duty ranges. They are supplied

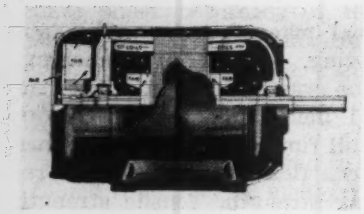


as groups comprising rim and disk, hub, bearing cones, grease seal and cap and with bent or straight spindles. Brakes are available in certain heavy-duty sizes only. Range load per wheel in light classification is 1200 to 1500 lb; medium, 1500 to 1750 lb; and

heavy, 1750 to 2,000 lb. Wheels in the several duty classifications are available for variety of tire sizes. Manufacturer: Kelsey-Hayes Wheel Co., Davenport, Iowa.

For additional information circle MD 5 on Page 159

Totally-Enclosed Fan-Cooled Motor

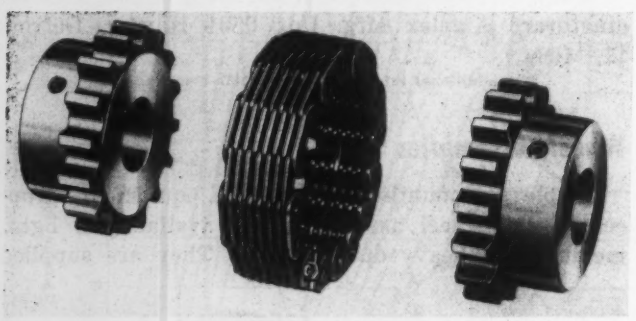


Small fan blades on rotor of type TEFC electric motor circulate air which is drawn through external hood over stator core and out over pulley bearing. During this process, heat is transferred from rotor and stator to frame and endbells. Actual temperature rise on stator windings will not exceed 55 C under full load operation. Ball bearing temperature rise in motor does not exceed 30 C. Ranging in sizes from 2 to 60 hp, motor is polyphase 56 or 60-cycle constant-speed, continuous-duty, squirrel-cage induction type with high starting torque and low starting current. Manufacturer: Valley Electric Corp., Dept. 118, 4221 Forest Park Blvd., St. Louis 8, Mo.

For additional information circle MD 6 on Page 159

Silent Chain Flexible Coupling

Combining high power transmission capacity with small space requirement, Series DSC silent-chain flexible coupling consists of two sprockets wrapped with center guide Morse silent chain. It transmits up to 119 hp at 2000 rpm. Stock bore ranges from ½ to



2⅞ inches are available as are covers of stamped steel or plastic. Disconnection is accomplished by unwrapping chain after removing connecting pin or by moving either sprocket endwise out of mesh with chain. Manufacturer: Morse Chain Co., 7601 Central Ave., Detroit 8, Mich.

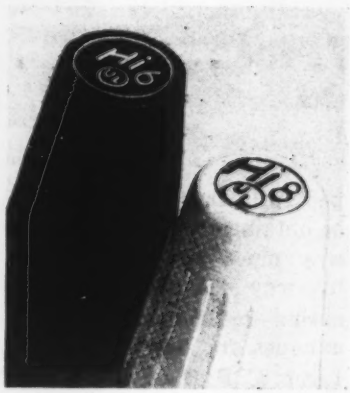
For additional information circle MD 7 on Page 159

Stainless Steel Alloy

Having high hardness and strength, possessing good corrosion resistance and requiring only low temperature hardening treatment, 17-4 PH stainless steel is recommended especially for gears, cams, shafting, chains, valves and pump parts. Containing 17 per cent chromium, 4 per cent nickel and 4 per cent copper, this alloy has corrosion resistance approaching that of 18-8 stainless steel. Hardness values of 40 to 45 Rockwell C, with high tensile and yield strengths, are obtained by precipitation hardening. This merely requires heating annealed material to approximately 900 F for about one hour and air cooling. This treatment eliminates problems such as quenching cracks, distortion, internal stresses and objectionable scaling. Since only easily removed surface discoloration is produced in precipitation hardening, parts can be finish machined before hardening. Manufacturer: Armco Steel Corp., Middletown, O.

For additional information circle MD 8 on Page 159

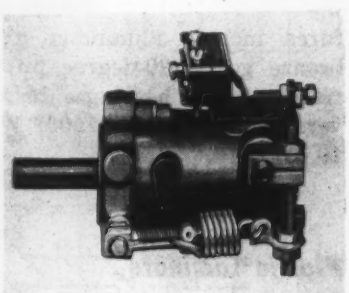
Plastic and Porcelain Wire Connectors



These Underwriters' Laboratories approved Hi plastic and porcelain wire connectors have contour which tapers off toward top so that they can be used in restricted spaces too small for conventional type connectors. High pressure molding process, precision coiling of taper springs and improved molding mixture prevents coil springs working loose from body of connector. Units can be used to join from two No. 18 wires up to three No. 10 wires with stranded wire or equal bulk. Large No. 6 universal Bakelite connector joins practically every combination of larger industrial wires. Improvements in porcelain connectors include raised lands for sure grip and faster splices. Manufacturer: Holub Industries Inc., Sycamore, Ill.

For additional information circle MD 9 on Page 159

Centrifugal Governor

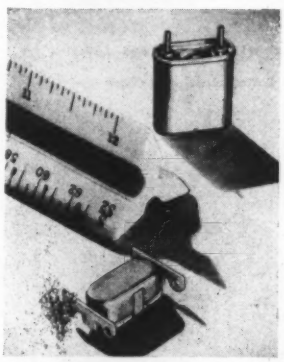


When predetermined speed limit has been exceeded, this microswitch centrifugal governor will turn off motor, engine or other electrically energized equipment. It is especially recommended for situations in which investigation or corrective measures must be taken before 'runaway' equipment is put back into operation. As switch must be reset manually before motor can be started again, damage is averted until repairs can be made. Microswitch is available on Pierce direct-drive and cable-driven centrifugal governors. Mercury

switch performs same functions as microswitch for operations involving fire hazards. Manufacturer: Pierce Governor Co., Anderson, Indiana.

For additional information circle MD 10 on Page 159

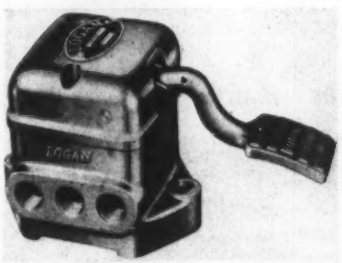
Positive Operating Thermostat



Featuring electrically independent bimetal strip thermal element, that eliminates artificial cycling, type C positive operating thermostat responds only to temperature changes in controlled device or surrounding air. Produced with variety of terminal arrangements and in many operating ranges up to maximum of 600 F, unit will operate normally at temperatures as low as −60 C. It can be used alone or in conjunction with disk type thermostats for precise control of low-wattage electrical circuits in communications, electronic equipment, apparatus and appliances. Standard and hermetically sealed styles are available. Latter type is also supplied as double unit set to open at both minimum and maximum temperature. Manufacturer: Stevens Mfg. Co., Mansfield, O.

For additional information circle MD 11 on Page 159

Air Control Valve



Built in ⅜, ¾ and 1-inch port sizes, model 6552 foot-operated four-way air control valve is designed for pressures up to 150 psi. Valve body and cover are high tensile cast iron and foot pedal is manganese bronze. All ports and internal air passages are full pipe size to permit unrestricted air flow, rapid response and fast operation. Valve cover can be rotated 90 or 180 degrees to simplify piping problems. When repairing or reconditioning, it is not necessary to remove air lines from valve or disturb pipe connections. Manufacturer: Logansport Machine Co., Logansport, Indiana.

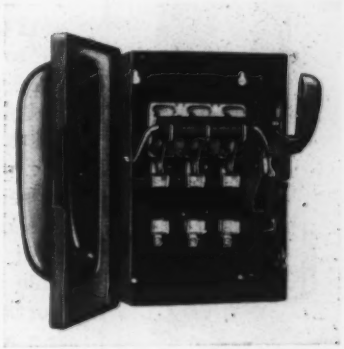
For additional information circle MD 12 on Page 159

Asbestos Sheet Packing

Developed to particular performance requirements of Army-Navy Aeronautical Specification AN-G-171, Palmetto compressed asbestos sheet packing No. 2915 combines high resistance to heat, oil and solvents with particular resistance to alcohol-water and ethylene-glycol-water mixtures. Because asbestos fibers have been sealed to prevent liquid absorption, this packing is highly impervious to such refrigerants as Freon. It has tensile strength with grain of 6150 psi, 10 per cent recovery at 1000 psi and 99 per cent recovery with no load, and will not crack if bent 180 degrees. Manufacturer: Greene, Tweed & Co., North Wales, Pa.

For additional information circle MD 13 on Page 159

Industrial Safety Switches



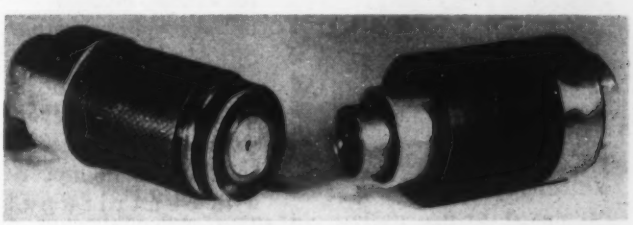
Added to line of safety switches are types A, C, and D for heavy-duty industrial service, standard-duty industrial service and general-purpose service, respectively. Type A switches have attachment that locks switch 'on' or 'off', and cover can be closed with from one to four padlocks. Current carrying parts are silver plated, and the blades are visible for quick checking of switch operation. Line terminals are dead front, protected by hinged arc chamber cover. Magnetic plate in arc chamber cover adds to high rupturing capacity of switches. Jaws and fuse clips are steel reinforced to exert positive pressure.

A nontracking insulation is used in the base, and insulating cross bar is formed of melamine plastic. Pressure connectors are removable so that solder lugs can be used when preferred. Types C and D are similar in appearance to type A, with design and construction details differing to meet service demands. Switches are now available in 30 and 60-amp sizes. Larger sizes are planned. Manufacturer: Square D Co., 6060 Rivard St., Detroit 11, Mich.

For additional information circle MD 14 on Page 159

Hydraulic Coupler

Usable on all types of hydraulically actuated implements, this breakaway coupler has free swivel action under all conditions up to 4000 psi which eliminates hose line twisting and kinking. When disconnected, coupler instantly checks flow of oil under

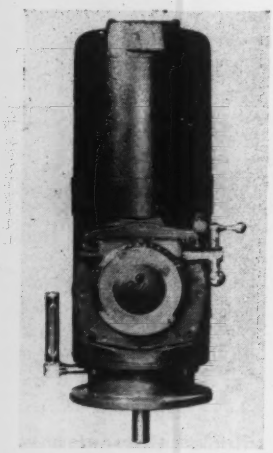


pressure, sealing both ends of the line. Oil spillage at breakaway does not exceed two drops, and pressure loss is held to a minimum. Standard rubber O-ring seals are used and the moving metal parts do

not contact each other. Coupler can be completely serviced in the field without special tools. Manufacturer: B. A. Coupling Co. Inc., 1658 N. Brookfield St., South Bend, Ind.

For additional information circle MD 15 on Page 159

Variable Speed Drive



Designed for vertical NEMA flange mounting, type F variable-speed transmission is available in sizes from ¼ to 1 hp. All speeds from 0 to 1100 rpm are obtainable by means of hand crank adjustment with speed indicating dial. The transmission closely maintains its set speed even with change in load and is particularly suitable for metering and proportioning uses or for mixing applications where change in viscosity occurs. Drive is available without motor or with built-in open or totally-enclosed non-ventilated three-phase or capacitor type motor. Manufacturer: Graham Transmissions Inc., Milwaukee 12, Wis.

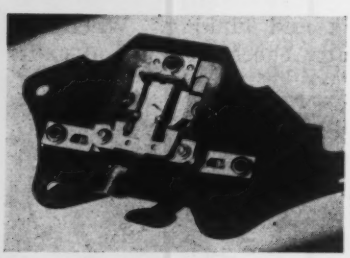
For additional information circle MD 16 on Page 159

Alloy Cast Steel

Exhibiting no structural changes at temperatures as low as −430 F, Lebanon grade 22 austenitic cast ferrous alloy contains 19.5 per cent chromium and 9 per cent nickel. Particularly applicable in oil, chemical and other processing industries, it has already been used in production of steel castings for pressure equipment in storage facilities for liquid oxygen. This alloy can be welded by gas or electric processes without need for subsequent heat treatment. Manufacturer: Lebanon Steel Foundry, Lebanon, Pa.

For additional information circle MD 17 on Page 159

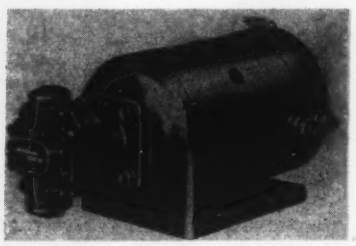
Motor Reversing Switch



Allowing split-phase and capacitator-start motors to be started in either direction, reversed instantly or brought to quick stop, Reverswitch replaces starting switch in motors with centrifugal starting mechanisms and will fit most standard fractional-horsepower motors. Its action is mechanical, being similar to conventional starting switches except for its having two contacts instead of one. Device can be used as ordinary starting switch to give simple one-direction starting. To achieve instant reversing some type of external controller is necessary. Basically, action of a three-pole double-throw switch is required. Since various types of standard starting and reversing switches, drum controllers and magnetic relays can be used, wide selection of both manual and automatic methods of control is available. Manufacturer: Iron Fireman Manufacturing Co., Portland, Ore.

For additional information circle MD 18 on Page 159

Pump-Motor Unit

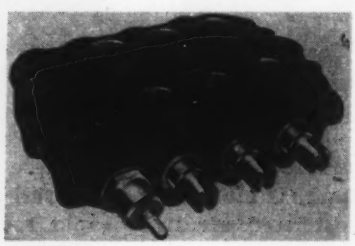


Addition to line of Barnes Constant-Flo rotary gear pumps is pump and motor unit which are exactly mated to each other. This assures maximum efficiency of both pump and motor for use with automotive and battery powered industrial equipment. Unit combines specific model gear pump best suited to customer's requirements with special 12-volt series motor.

Illustrated model delivers 2.5 gpm at 650 psi and 2.0 gpm at 1000 psi. Maximum pressure is 1500 psi. Models are available in ¼-inch ports with built-in relief valve, and with special ports and mounting brackets to suit application. Manufacturer: John S. Barnes Corp., Rockford, Ill.

For additional information circle MD 19 on Page 159

Hydraulic Control Valves



These V8 series oil-hydraulic valves will handle 80 gallons of oil per minute at operating pressures up to 1000 psi. They are recommended for use on road building and earthmoving equipment as well as hydraulic presses. Various models can be obtained for operating up to as many as three single-acting or double-acting hydraulic cylinders. Valves employ hollow-plunger construction with built-in check valves and adjustable differential type relief valves. Manufacturer: Hydraulic Equipment Co., 1100 E. 222nd St., Cleveland 17, O.

For additional information circle MD 20 on Page 159

Stainless Steel Piston Rings

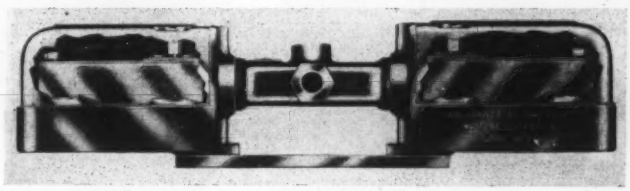
Stainless steel, which maintains tension under extreme temperatures and is corrosion resistant, is employed in this series of nonbreakable piston rings. Free from distortion, rings minimize friction and wear

by providing dissimilar metal for rubbing surfaces and increase compression efficiency by near-constant expansion factor which permits close tolerances between ring and cylinder wall. Rings are formed from open-end metal to true circle proportions and heat treated in that shape. They are ground on outside diameter and lapped on sides for efficient seating. Lapping permits use of two rings in one ring groove for maximum efficiency. Manufacturer: Steel or Bronze Piston Ring Corp., Indianapolis 25, Ind.

For additional information circle MD 21 on Page 159

Electric Air Valves

Designed for air pressures up to 125 psi, line of double-solenoid valves is supplied in sizes of 3/8, 1/2, and 3/4-inch. All sizes are available for 110, 220 and 440-v operation on both 25 and 50-60 cycle current. Valve has one-piece bronze base, heavy solenoids for



positive seating and cool operation, and heavy sheet metal cover. Type OU packer is utilized as well as shock-resisting clevis and clevis pin. Models are available in all sizes with two-way, three-way or four-way piped exhaust. Manufacturer: Valvair Corp., 454 Morgan Ave., Akron 11, O.

For additional information circle MD 22 on Page 159

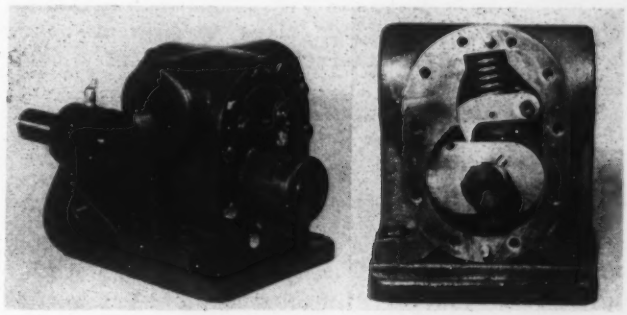
Metal Finishing Primer

Manufactured as universal primer, Di-Noc Metal N33 is designed especially for aluminum but is adaptable for steel and other metals. Material has high abrasion resistant characteristics and will adhere to aluminum without special preparation. After application of primer, any regularly used over-coat may be applied. It can be used in air-dry, force-dry or bake-dry applications. It is supplied in neutral gray or white colors and packaged in 5-gallon containers. Manufacturer: Di-Noc Co., 1700 London Rd., Cleveland, O.

For additional information circle MD 23 on Page 159

Rotorarm Rotary Pump

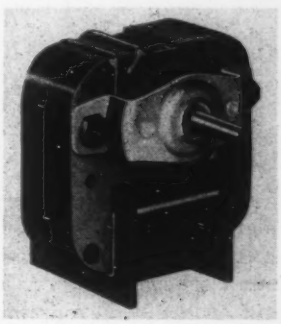
Positive displacements of 11 to 27 gallons per minute at discharge pressures up to 100 psi when handling lubrication fluids are possible with this Rotoarm rotary pump. Two elliptical rotors are set on same shaft. Two swinging arms ride on these rotors to prevent recirculation and to assure constant delivery. Pump operates at from 400 to 1000 rpm and is capable of producing a vacuum of 28 inches of mercury. Nickel castings with stainless steel fittings



are standard to protect against corrosion. Other features include mechanical shaft seal, permanently mounted outboard shaft bearing and in-line suction and discharge ports. Manufacturer: Hinckley Technical Associates Inc., 299 Marginal St., East Boston, Mass.

For additional information circle MD 24 on Page 159

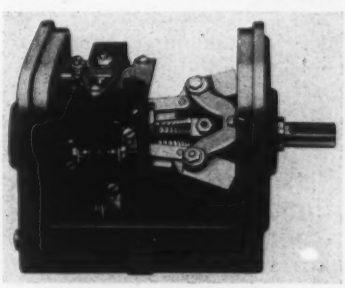
Small Skeleton Motor



Built in sizes ranging from 1/500 to 1/100-hp, type AG small skeleton 2-pole offset a-c motor weighs only 21 oz. Features include air gap concentricity, heavy bearing brackets, oil reservoirs packed with felt and enameled windings. Two holes in field laminations facilitate mounting. Applications include use in small room heaters, fans, animated displays and other equipment requiring light weight, low power motors. Manufacturer: Redmond Co., Redmond Sq., Owosso, Mich.

For additional information circle MD 25 on Page 159

Electric Centrifugal Switch



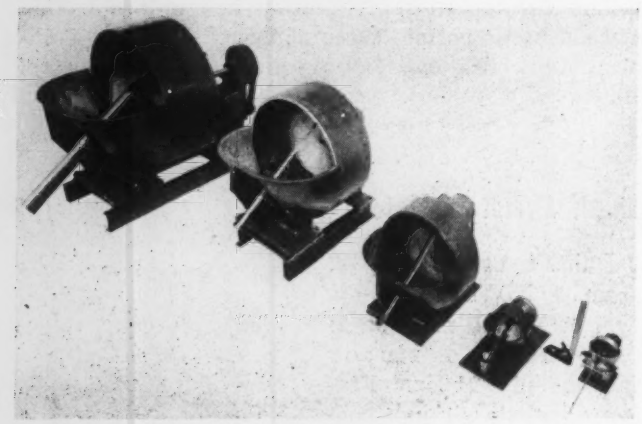
This centrifugal switch has been redesigned for plugging, overspeed or underspeed protection, nonplugging and motion interlocking service. It is particularly suited for application on machine tools to increase production and on hazardous machinery to increase safety. Available in dust-tight and oil-resistant enclosures for surface or flange mounting and also in permissible enclosures for hazardous locations, this switch can be furnished with any standard contact arrangement and has operating range for contacts to open or close at from 125 to 2530 rpm. It has sealed and permanently lubricated ball bearings. Major improvements are ball

bearing mounted on contact-making arm to minimize friction and contact-blade stops to prevent undue wear of contacts. Manufacturer: Euclid Electric & Mfg. Co., Madison, O.

For additional information circle MD 26 on Page 159

Parts Hoppers

Ranging in size from 4 to 32 inches, illustrated motorized hoppers are designed for feeding specific parts. For example, 4-inch model handles screws 0.227-inch long and 0.045-inch in diameter; it is used in conjunction with another hopper to handle washers of 0.1-inch diameter and 0.025-inch thick with 15-degree bevel. These hoppers are used to feed orientated parts into nests of special assembly machine, where washer is placed on screw right side up and assembly is ejected, the entire process being accomplished automatically. Manufacturer: Kraus Design Inc, 41 S. Water St., Rochester, N. Y.



For additional information circle MD 27 on Page 159

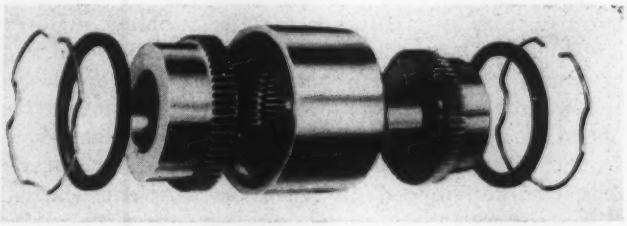
Countersunk Pipe Plugs

Made of specially selected steel on automatic screw machines, these countersunk pipe plugs are available in standard stock sizes of ¼, ⅜, ½, ¾ and 1 inch. They can be furnished also to special order in alloy steels, aluminum or brass in sizes up to 2⅝ inches in diameter. Usable as removable drain plugs, permanent plugs and for other applications, they are supplied with standard pipe or Dryseal threads. Manufacturer: J. J. Tourek Mfg. Co., 4710 W. Sixteenth St., Chicago 50, Ill.

For additional information circle MD 28 on Page 159

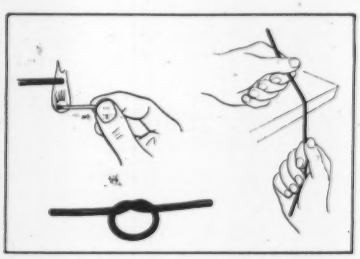
Gear-Type Flexible Coupling

Utilizing but seven parts, this gear coupling is of forged high-carbon steel with internal teeth running full working length. Sleeve can be removed quickly as it is held without bolts. Hub teeth are cut radially, permitting accurate alignment without excessive backlash. Neoprene seals are reinforced with garter springs which maintain constant closure against slight depressions and unevenness of shaft surfaces. Coupling is supplied in sizes of ¾, 1, 1½, 2, and 2½ in. Manufacturer: Sier-Bath Gear & Pump Co. Inc., North Bergen, N. J.



For additional information circle MD 29 on Page 159

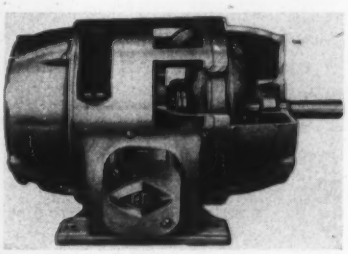
Fiberglas Wire Sleeving



Available at price comparable to cotton or rayon-base insulations, BH 649 braided Fiberglas tubing and sleeving will withstand rough handling without breakdown. Noncombustible material is treated to retard fraying and can be knotted and pulled tight without cracking or change in dielectric strength. Potting temperatures of 450 F may be used up to 60 minutes. Material is supplied in Grade A-1 and B-1 tubing and grade C-1 and C-2 sleeving in standard black or yellow, as well as green or brown. Sizes range from No. 20 to ⅝-in. inclusive. Manufacturer: Bently, Harris Mfg. Co., Conshohocken, Pa.

For additional information circle MD 30 on Page 159

Fluid Drive Motor

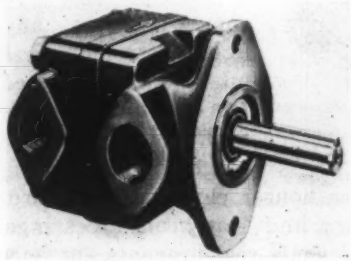


Usable wherever loads require smooth acceleration, protection from jamming and shocks or where starting conditions are difficult, these Fluid Shaft motors consist of fluid-drive coupling and electric motor integrally mounted on standard frame and end bells. Loads that are difficult to bring up to speed are accelerated easily as motor is practically at operating speed before load is applied. All starting and operating shocks are absorbed in cushion of oil. Units are available in ½, ¾, 1, 1½, 2, 3, 5, 7½, and 10 hp with standard foot mount or round body frame. All can be mounted horizontally or vertically, and can be supplied with NEMA flange or face type end bells. Units are also available as motor reducers in either

single or double reduction types. They provide fluid-drive, electric motor and gears for slow output speeds in one compact power package. Manufacturer: Reuland Electric Co., Alhambra, Calif.

For additional information circle MD 31 on Page 159

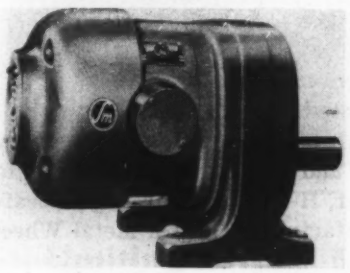
Hydraulic Pump



Expressly designed for mobile equipment industry, Series V-200 balanced vane pump automatically maintains correct radial and axial clearances at all times. Pump is not only compensated for normal wear, but also adjusts its clearances automatically to oil viscosity variations resulting from temperature change. Hydraulic balance feature eliminates bearing loads resulting from pressure, and vane principle provides for no-load starting. Pump is suppied in four capacities for operating pressures up to 1000 psi. Minimum delivery varies from 1.6 to 11.2 gpm at drive speeds from 600 to 2750 rpm. Furnished with magneto, face, foot or flange mounting, it is directly coupled or belt, chain or gear driven. Manufacturer: Vickers Inc., 1400 Oakman Blvd., Detroit, Mich.

For additional information circle MD 32 on Page 159

Totally-Enclosed Motor

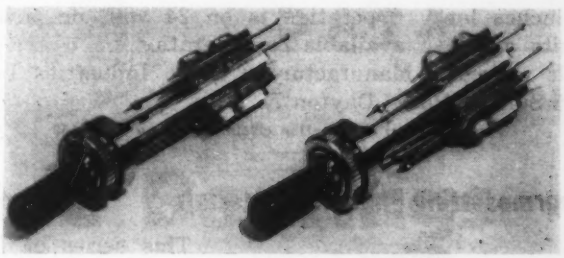


Improvement feature of type FWFB Slo-Speed geared motor is Klosd-Tite construction for use in atmospheres containing nonexplosive dusts vapors and injurious foreign materials. External fan cools streamlined case. Other features include labyrinth seals, heavy-duty ball bearings lubricated for life, Sterling gears and Herringbone rotor. Motor can be mounted in any position without modification. Manufacturer: Sterling Electric Motors Inc., Los Angeles, Calif.

For additional information circle MD 33 on Page 159

Lever-Action Switch

Especially adaptable for use on all types of low-power switching applications, Lev-R switch requires less than one-half space usually necessary for a lever switch. A single hole is required for mounting. Switches are furnished in standard circuits with two or three-position actuators and in either locking or nonlocking type. Mounting hardware is nickel-plated brass. Fine silver contacts, rated at 3 amp 120 v a-c,

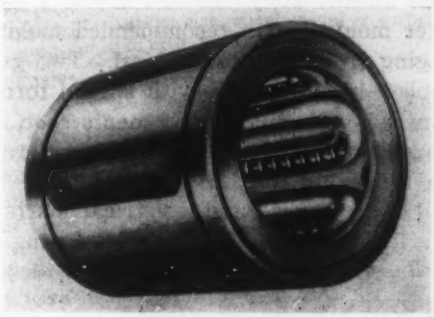


noninductive load, are standard. Large silver contacts for high currents and palladium contacts for low-current, low-voltage circuits are available. Overall length is 3 17/64 in., width is $\frac{5}{8}$-in. and height depends on circuit. Manufacturer: Switchcraft Inc., 1328 N. Halsted St., Chicago 22, Ill.

For additional information circle MD 34 on Page 159

Linear Ball Bushing

Having substantial load rating and suitable for use where shaft rigidity and capacity are important, this Ball Bushing is designed to give antifriction support to linear motions along 1½ inch diameter

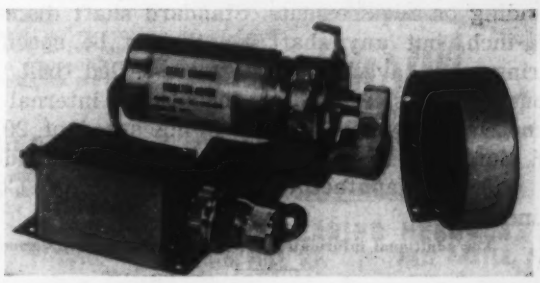


guide rods or reciprocating shafts. Precision alignment is maintained over long periods since free-rolling ball bearing action reduces wear. Bearing has $2\frac{3}{8}$-inch outside diameter and 3-inch overall length. Manufacturer: Thompson Industries Inc., Manhasset, N. Y.

For additional information circle MD 35 on Page 159

Electric Vibrator

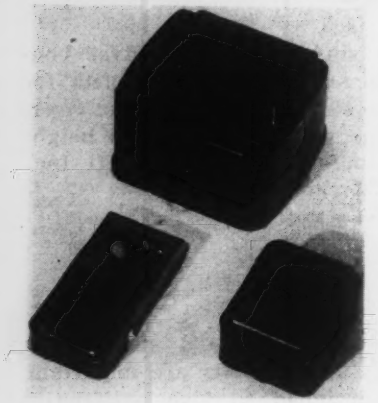
Shaking forces up to 6 lb at frequencies of the order of 30 cps are produced by the Globe electric vibrator. Unit consists of a power unit to which is attached an unbalanced arm. Furnished with a complete shielding and filter for radio-noise suppression the assembly weighs under one pound and is



4 inches long. Operation is on 24 volt, dc power. Units are also available for operation on 6 and 12 volt current. Manufacturer: Globe Industries Inc., 125 Sunrise Place, Dayton 7, Ohio.

For additional information circle MD 36 on Page 159

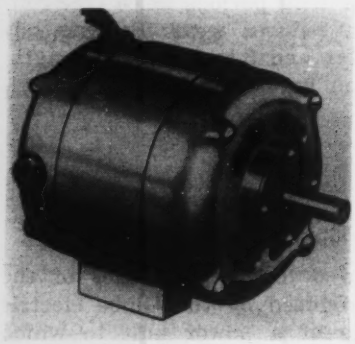
Thermosetting Phenolic Materials



This series of Luron medium-high impact thermosetting phenolic materials has low bulk factor and fast rate of cure and can be molded in high-speed, multicavity molds. Clean and dustless, materials are of uniform particle size and are easily poured or automatically preformed, emerging from mold with a high gloss finish. They can be compression, transfer or plunger molded, with recommended molding pressure ranging from 4000 to 6000 psi. Two grades are now supplied in black only, with special formulations and colors for individual requirements soon available. Processing characteristics of these phenolic materials make them usable for large transformer housings, industrial tote boxes, and electrical parts. Manufacturer: Rogers Corp., Manchester, Conn.

For additional information circle MD 37 on Page 159

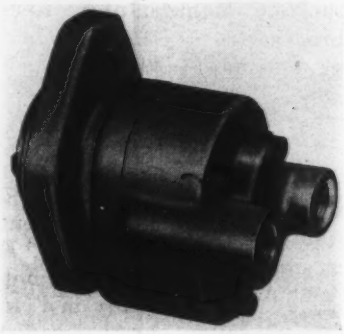
Electric Motor



This model 700 motor can be series wound to match needs of application from 1/15 to ½-hp for continuous duty or ¾-hp for intermittent use. When shunt wound, motor has intermittent-duty rating of ½-hp. It can be wound for range of 6 to 230 volts dc or ac-dc. Housing can be ventilated or totally enclosed, with black enamel, crackle or special finish. Rotation is clockwise, counter-clockwise or reversible, depending on requirements. Standard shaft diameter is ⅜-inch, but any shaft length can be specified. Bearings are available in grease-sealed ball and porous bronze sleeve types. Included is internal fan to cool motor which has top idling speed of 20,000 rpm. Motor can be used with variety of gear reducers and bases. Manufacturer: Electric Motor Corp., Racine, Wis.

For additional information circle MD 38 on Page 159

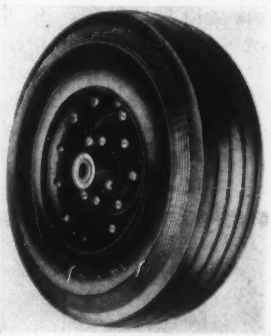
Rotary Gear Hydraulic Pump



Applicable to heavy-duty hydraulic power demands, model RC-7380 Lear-Romec rotary gear type pump delivers 5 gpm at 1000 psi and 1800 rpm. It uses any light petroleum-base oil and is designed for direct drive from SAE flange type magneto mounting pad. Cast aluminum case houses closely fitted, hardened-steel impeller gears and lead-bronze bearings. Air check in mechanical shaft seal prevents entrance of air during self-priming starts. Ports are tapped for ½-in. or ⅜-in. NPT inlet. Manufacturer: Lear Inc., Romec Pump Div., Elyria, O.

For additional information circle MD 39 on Page 159

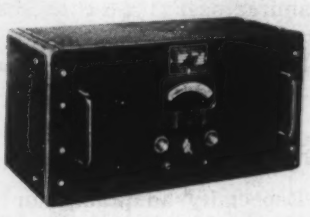
Industrial Disk Wheel



This 14-inch No. D265 disk wheel with 4.00 x 14 punctureproof semipneumatic tire is supplied in wide range of hub lengths and bearing types and sizes to serve variety of purposes. Prevention of tire slippage is assured by perfect meshing of tire lugs into wheel lugs. Tires are light or heavy-duty types for maximum rated loads of 385 and 595 lb, respectively. Hub lengths vary from 2½ to 4½ inches and axle diameters from ½ to 1¼ inches. Ball, G-roller, H-roller or Durex type bearings are utilized. Manufacturer; Geneva Metal Wheel Co., Geneva, O.

For additional information circle MD 40 on Page 159

Automatic Voltage Regulator



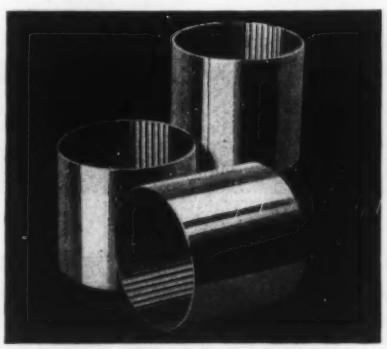
Small automatic voltage regulator, Stabiline EM 4102, is electromechanical in operation consisting of a variable transformer controlled by an electronic detector. Ratings are: input range, 95 - 135 volts; output, 0-2 kva adjustable between 110 and 120 volts; input frequency range, 50-60 cycles; wave form distortion, zero per cent; recovery time, 3 seconds for line voltage excursions of 95-135 volts, or 0.075 seconds per volt. The regulator is completely

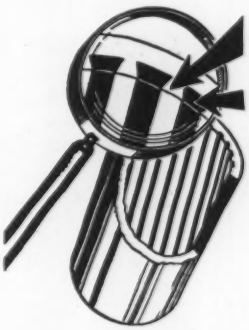
Graphited Bronze Bearings

GRAPHITED SLEEVE TYPE BEARINGS were developed primarily for applications where lubrication is difficult, likely to be neglected and where the speed of the shaft is too slow to sustain an oil film. They are also used in some applications where ordinary lubricants might damage goods or food products in process and where temperatures are too high for oil or grease.

There are three fundamental types available: cast bronze with serrated grooves, cast bronze with graphite plugs and bronze sheet metal with serrated, rectangular or diamond shape indentions.

In the cast bronze serrated type, minute, dovetailed grooves are cut into the bearing surface at a 7 degree lead. Graphite is then compressed into these serrations and remains permanently in place. This type provides from 40 to 45% graphite contact with the shaft which increases slightly with wear.





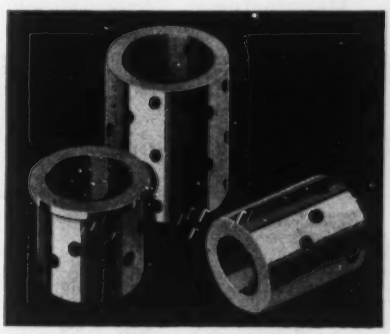
· · · Serrated type graphite bearing. Note the 7° lead and the dovetail shape of the serrations.

Plug type graphited bearings are produced by drilling holes of a suitable size in a cast bronze bearing on a staggered pattern through the wall. Stick graphite is then forced into these holes and remains permanently in place.

In some applications, ordinary oil grooves or combinations of oil grooves can serve as recesses to hold the graphite. It is also possible to compress graphite into grooving on the flange of cast bronze bearings when the application requires it.

The first step in producing bronze sheet metal graphited bearings is to cut serrations longitudinally into coiled strips of sheet bronze. The graphite is then forced into these serrations by a high pressure, patented process and baked under a carefully controlled temperature. The strip material is then blanked and formed into cylindrical shapes. In producing the cylindrical shape the serrations automatically become dovetailed which holds the graphite permanently in place.

Cast graphited bearings can be reamed in place, a maximum of 0.005 stock being removed. Sheet metal bearings *must* be burnished in place. The graphite used in Johnson bearings is not soluble in water, oil or gasoline. An occasional application of oil or grease where permissible will greatly increase the life of the bearing and lower the coefficient of friction. Cast graphited bearings are recommended for applications having slow speeds and minimum loads. For intermittent service or oscillating motion we recommend sheet metal with graphite. Quantity is a factor also and in large production runs of any given size, sheet metal is surprisingly low in cost.



Limiting Factors For Successful Performance

1-Speed—Load Factors:

(a) For constant running shafts—PV=18,000# in (min.) sq. in. proj. area.

(b) For constant running shafts (with supplementary lubrication) PV=120,000# in (min.) sq. in.

(c) For Oscillating shafts—PV=60,000# in (min.) sq. in.

(d) Intermittent service—PV=120,000# to 250,000# in (min.) sq. in. (use safety factor)

2-Bearing Pressures:

(a) All graphite jobs (without additional lubrication) 40 to 50# sq. in. (for speeds of 30 ft. per min.)

(b) With supplementary lubrication 350# sq. in.

3-Temperatures:

(a) Standard graphited bushings—Satisfactory up to 250° F. 275° F. (Using conventional leaded bronzes and serrated type.)

(b) For temperatures up to 400° F. Conventional leaded bronzes with graphite plugs.

(c) For temperatures—Up to 1000° F. Special lead bronze alloys with graphite plugs. At higher loads, oil should be used in conjunction with the graphite plugs for higher efficiency.

4-Running Clearances:

(a) Constant running shafts—50% higher than standard.

(b) Oscillating shaft—Standard allowance can be used.

5-Wall Thickness:

Minimum thick.
1/16" for O.D. up to 1".
Minimum thick. Serrated type
3/32" for O.D. over 1".
Max. wall thick.—Optional to designer. For plug type graphite—wall to be same as diameter of graphite plug—⅛ min.

6-

Graphited bushings should be recommended for speeds less than 30 ft. per min. for at such low speeds it is impossible to develop film pressure necessary to prevent metallic contact.

7-Stock Allowance for finishing

(a) It is necessary to finish bushing in assembly. Reaming stock allowance of not more than 0.005 should be allowed for cast bronze graphited.

(b) At least 0.004 stock for burnishing sheet metal graphited.

Ledaloyl Bearings

While graphited bearings are sometimes referred to as "Self-Lubricating" Johnson Bronze produces another type by powder metallurgy known as *Ledaloyl*. This bearing is low in cost, high in efficiency and holds up to 35% oil by volume. It is particularly economical when produced as a self-aligning, flanged or other odd shaped part as there is no machining required. Write for complete details.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

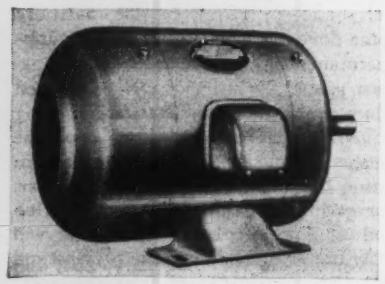
Johnson Bronze

SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

insensitive to the power factor of the load and is being offered as a cabinet-contained or rack-mounting unit. The rack type fits standard 19-in rack panels; the cabinet model is convertible to rack mounting. Manufacturer: The Superior Electric Co., 80 Hannon Ave., Bristol, Conn.

For additional information circle MD 41 on Page 159

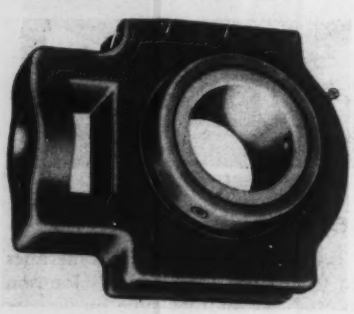
Totally-Enclosed Motor



Cooling is improved in this B-Line motor by a fan which directs air directly over stator lamination edges to eliminate dead air space completely. Motor windings as well as brushes and other internal parts are protected by enclosed frame which permits motor to be used where metallic and abrasive dusts are present. Motor is equipped with prelubricated ball bearings, is rated 55 C for continuous duty and can be obtained in single-phase from ½ through 3 hp and in polyphase from ¾ to 3 hp. Manufacturer: Brown-Brockmeyer Co., Dayton 1, O.

For additional information circle MD 42 on Page 159

Ball Bearing Take-Up



Suitable for conveyor and power transmission service, wide slot SC ball bearing takeup permits adjustments to be made for changes in shaft position. Unit consists of deep-groove precision bearing, with large balls and retainer to minimize wear, enclosed in strong outer housing with wide milled slots or ways on each end for supporting guides. Housing has hole for receiving unthreaded end of adjusting screw. Manufacturer: Dodge Manufacturing Corp., Mishawaka, Ind.

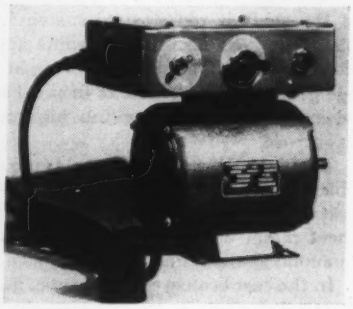
For additional information circle MD 43 on Page 159

Silicone Insulating Resin

Having general application for impregnating spun glass and asbestos wire coverings and for binding coils, windings and other motor, generator and transformer parts, No. 9989-1 thermosetting silicone insulating resin permits electrical equipment to operate at temperatures as high as 180 C. Possessing high dielectric strength, water resistance and heat resistance, it dries tack-free in less than 30 minutes at relatively low temperature and can be cured to tough flexible film. It has solids content of 60 per cent and average viscosity of 200 centipoises at 25 C. Material can be used as supplied or thinned with petroleum spirits or VM & P naphtha. Manufacturer: General Electric Co., Chemicals Division, Pittsfield, Mass.

For additional information circle MD 44 on Page 159

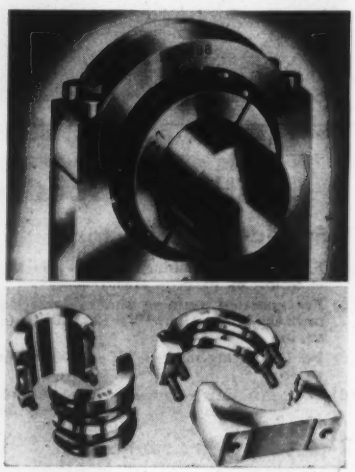
Synchronous Motor



Providing three synchronous speeds in one unit for production and laboratory work, model GH-371 Elnico hysteresis type synchronous motor can be switch or relay controlled and is reversible while running. It can change also from one speed forward to different speed in reverse. Motor is rated at 1/100, 1/60 and 1/40-hp at 900, 1800 and 3600 rpm, respectively; and it operates from 115-volt 60-cycle single-phase current. It can be furnished complete with control box and line cord, wired and ready to use. Manufacturer: Electric Indicator Co., Stamford, Conn.

For additional information circle MD 45 on Page 159

Pillow Blocks

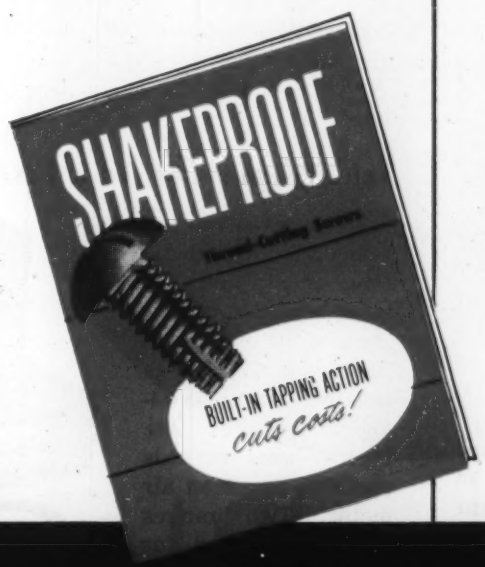


Correction: This pillow block which was announced in the August issue, listed erroneously the manufacturer as the Kohler Co. instead of the Split Ballbearing Corp., Lebanon, N. H.

The housing and outer race of this pillow block are forged integrally from bearing steel. Both inner and outer races are split or fractured and repositioned by holding screws. This construction permits the assembly of the bearing in places where a solid race bearing cannot be installed. It is compact and has a high load capacity, due to the maximum complement of balls that can be assembled in the split construction. Now available for shafts 15/16 to 3 15/16 inches in diameter. Manufacturer: Split Ballbearing Corp., Lebanon, N. H.

For additional information circle MD 46 on Page 159

ELIMINATE TAPPING IN *any* MATERIAL



Type 1 Shakeproof Thread-Cutting Screw — ideal for a wide range of steels, stainless steels and the harder alloys.

Type 23 Shakeproof Thread-Cutting Screw — assures efficient thread-cutting action in the softer metals and die castings.

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See how Shakeproof Thread-Cutting Screws will reduce your production costs!

Shakeproof Thread-Cutting Screws actually cut their own snug mating threads in practically any material . . . costly separate tapping operations are completely eliminated! The exclusive Shakeproof thread-cutting slot in each screw forms a sharp, serrated *cutting* edge . . . assuring true tapping action as the screw is driven. Special heat treatment makes Shakeproof Thread-Cutting Screws stronger too . . . nearly twice as strong as ordinary machine screws! And, because each screw fits tightly in its self-cut, perfectly mated thread, maximum resistance to vibration loosening is assured!

All these advantages will make your assembly process simpler and more efficient . . . see how in the new Shakeproof Thread-Cutting Screw book. You can check the typical applications shown against your own . . . and there's convenient technical data too! Write for your free copy today!

SHAKEPROOF Inc., Division of Illinois Tool Works, 2501 North Keeler Avenue, Chicago 39, Illinois. In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario.

Type 25 Shakeproof Thread-Cutting Screw — provides maximum resistance to stripping and decreases internal stresses in plastic applications.

Shakeproof

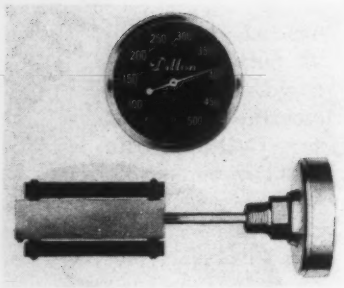
THREAD-CUTTING SCREWS

FASTENING HEADQUARTERS
TRADE MARK

engineering dept equipment

For additional information on this new equipment see Page 159

Magnetic Thermometer



Magnets on flat stem of this thermometer enable operator to place it on flat surface so that it quickly indicates temperature of surface under test. Such applications include checking electric flat irons, griddles, transformers, engine blocks, air ducts and exhaust ports. It can be screwed also into tanks, kettles and steam lines by removing magnetic portion of stem. Suitable mounting nuts are provided for this purpose.

Made of 18-8 stainless steel, it can be obtained with dial sizes from 1 to 5 inches in diameter, stems ranging from 3 to 42 inches long and calibrated in either Fahrenheit or Centigrade in nine different temperature ranges. Instrument is accurate to within 1 per cent of full scale reading and will withstand 3476 psi. Manufacturer: W. C. Dillon & Co., 5410 W. Harrison St., Chicago 44, Ill.

For additional information circle MD 47 on Page 159

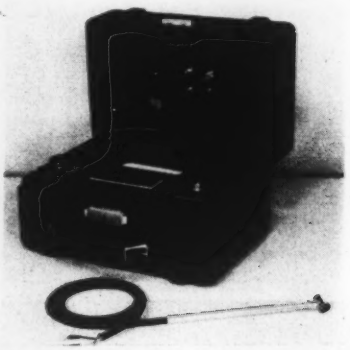
Engine Pressure Indicator

Giving accurate readings at detonation and power stroke frequencies, model 2 DC engine pressure indicator utilizes catenary diaphragm-actuated strain gage which exhibits negligible temperature, calibration drift, vibration and mounting stress error effects. Linear response to wide frequency range allows use for both static and dynamic pressure measurements. With low-pressure air cooling of pickup, accuracy within 1 per cent is obtained from −10 to 2000 psi over frequency range from d-c to 20,000 cycles per second. Static pressures to over 3000 psi can be measured, and calibration can be checked by dead weight test.

Amplifier-power supply unit receives electrical output of pressure pickup and supplies signal that can be fed into standard oscilloscope for graphical presentation of pressure-time curve. This signal can also be used for remote indication and telemetering applications. Calibration of scope trace is obtained by actuating panel switch which provides standard reference voltages corresponding to known values of pressure as read on directly-calibrated dial. Amplifier is battery operated and self-contained. Manufacturer: Control Engineering Corp., 863 Washington St., Canton, Mass.

For additional information circle MD 48 on Page 159

Velocity Meter for Air & Gas



Measurement of air velocities in ducts, flow in air and gas lines, surveys of heating and air conditioning systems, process control and meteorological studies are typical uses of this portable precision air meter. Two ranges are incorporated for velocities of 0-400 fpm and 400-6000 fpm. Instrument is accurate on velocities as low as 5 fpm. Operated from any 110-v a-c power source, instrument is housed in cast aluminum case and incorporates voltage regulated power supply. Provision is made for remote indication or operation of strip or chart recorder. Manufacturer: Hastings Instrument Co., Hampton, Va.

For additional information circle MD 49 on Page 159

Servomechanism Test Instrument

Designated as Type 6 servo analyzer, this portable unit provides dynamic response data on any system using 400 or 60 cycle amplifiers regardless of the type of motor or actuator employed. It requires no oscilloscope or other auxiliary equipment for making a-c tests. A demodulator is available for d-c tests. The wide-range, a-c vacuum tube voltmeter which is built into the instrument may be used separately. Amplitude ratio and phase angle of the transfer function, resonance function or error function may be

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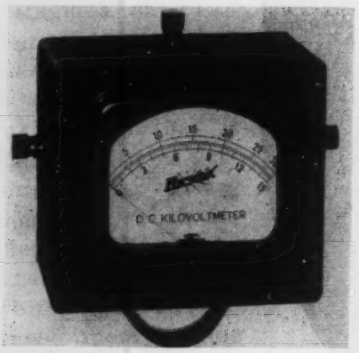
obtained at any frequency from 1/5 to 30 cycles per second. The instrument is applicable to laboratory development work, performance evaluation, routine maintenance, and production line testing. Manufacturer: Flight Research Engineering Corp., Richmond, Va.

For additional information circle MD 50 on Page 159

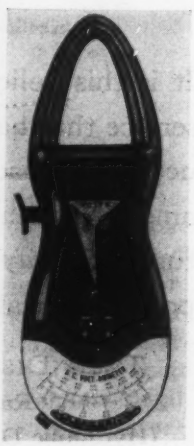
Kilovoltmeter



Installing and servicing induction heating, laboratory and other high frequency equipment as well as testing can be performed with this S44A portable direct current kilovoltmeter. It is supplied in sturdy molded black phenolic case measuring 6⅛ x 7⅛ x 4¾ inches and has double range of 0 to 15,000 and 0 to 30,000 volts. At full scale deflection, current drain is 100 microamperes, and instrument has sensitivity of 10,000 ohms per volt. Manufacturer: Hickok Electrical Instrument Co., 10545 Dupont Ave., Cleveland 8, Ohio.

For additional information circle MD 51 on Page 159

Portable Voltmeter

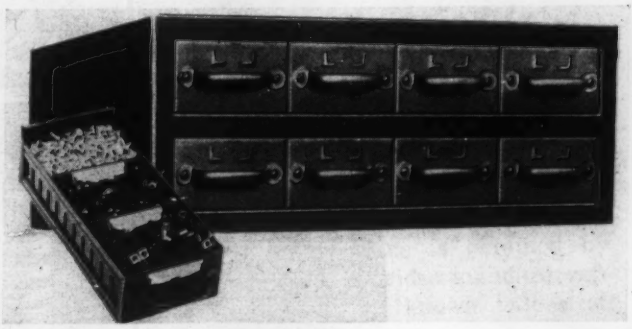


This pocket-sized Amprobe measures current and voltage without interrupting service. Plastic finger trigger opens transformer probes so that they can clamp around conductor to measure current in circuit. Voltage is measured by inserting test leads in front-mounted pin-jacks and connecting them to line. Instrument is available in two models, each with seven ranges: model A-5 is 6.5/13/26/65/130 amp and 130/260 v; and model A-6 is 10/25/50/198/250 amp and 150/600 v. Instrument is completely insulated, and no metal parts come in contact with operator. Accuracy is plus or minus 3 per cent of full scale. Manufacturer: Pyramid Instrument Co., 49 Howard St., New York 13, N. Y.

For additional information circle MD 52 on Page 159

Steel Drawer Cabinets

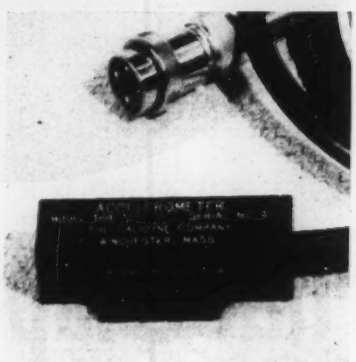
Providing handy storage space for small parts, Equipto steel drawer cabinets feature unit welded steel frame and adjustable cross dividers on 1-inch centers. Lengthwise dividers can be added or removed,



and label holders are furnished on every drawer and divider. Drawer size is 11⅞ x 5⅜ x 3⅛ inches. Available in two sizes with 8 or 18 drawers and 24 or 72 adjustable compartments, respectively, cabinets are finished in green enamel. Manufacturer: Aurora Equipment Co., Equipto Div., Aurora, Ill.

For additional information circle MD 53 on Page 159

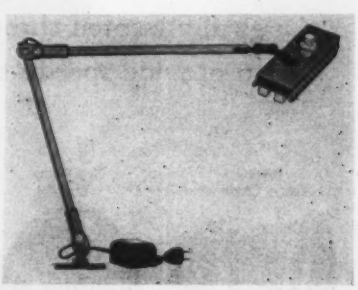
High-Frequency Accelerometer



Allowing direct operation of voltage and current-sensitive indicators and recorders, model 18 accelerometer will obtain natural frequencies as high as 1700 cycles per second without amplifying equipment. Pickups having natural frequencies from 80 to 450 cycles per second have corresponding range of sensitivities from 15 to 0.21-volt per gravity acceleration, and acceleration rates from 1 to 70g. Protected against overload shocks, instruments are d-c operated and can furnish as much as 400 microamps into 1000 ohms impedance or 20 volts into 1 megohm at full range output without amplification. Manufacturer: Calidyne Co., 751 Main St., Winchester, Mass.

For additional information circle MD 54 on Page 159

Adjustable Lighting Fixture



Producing light intensity of 550 footcandles at 3-inch working distance from twin 4-watt fluorescent lamps, model 10 miniature fluorescent lighting fixture provides intense but cool glare-free illumination for critical work. Wide choice of support arm lengths and arrangements is offered. Fixtures operate on 115 or 220-v a-c and 110-v d-c. Manufacturer: Stocker & Yale, 48 Birch St., Marblehead, Mass.

For additional information circle MD 55 on Page 159

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

74. Air-Hydraulic Equipment

Logansport Machine Co.—20-page illustrated pocket-size booklet "The Facts of Life on Air and Hydraulic Devices" presents practical guidance on setting up and servicing this type of equipment. Manual deals with air and hydraulic valves; air hydraulic and Airdraulic cylinders; hydraulic power units; lines and power chucks.

75. Electric Motors

Howell Electric Motors Co.—4-page illustrated condensed price list No. 1124 contains brief descriptions of single and polyphase fractional and integral horsepower motors of practically all types. Prices are listed for entire line.

76. Hydraulic Control Valves

Hydraulic Equipment Co.—4-page illustrated folder file No. V16-11248 describes Hydreco series V16 control valves having maximum capacity of 5 gallons per minute and recommended for operating pressures up to 1400 pounds per square inch.

77. Illuminated Magnifier

Dazor Mfg. Corp.—4-page illustrated form No. 588 explains how the Dazor Floating Magnifier can be adjusted readily for inspection, testing, assembly, first aid and other work. Integral fluorescent lighting provides shadowless illumination of work.

78. Control Valves

Ross Operating Valve Co.—12-page illustrated bulletin No. 311 describes large and small three-way and straightway valves. Large units are solenoid air-pilot operated, and small are direct solenoid operated. They are suitable for use on machine tools, jigs and fixtures, and similar equipment.

79. Variable Speed Drive

Louis Allis Co.—20-page illustrated bulletin 611-D shows how Adjusto-Spede unit provides infinitely variable speed output with constant torque characteristic. Drive operates directly from two or three-phase alternating current source. It utilizes new eddy current principle without motor-generator or exciter.

80. Relays

Advance Electric & Relay Co.—48-page illustrated bulletin "Advance Relays" presents complete specifications and details of general circuit, industrial control, telephone type, time delay, overload and many other relays in open and totally enclosed types. List prices are given.

81. Pneumatic Controls

Westinghouse Air Brake Co.—6-page pocket-size folder "Pneumatic Devices for Remote Control Systems" shows Tite-Air diaphragm type valve, cylinders, Flexair valves, actuators, Controlair valves and other pneumatic equipment.

82. Strain Gages

Baldwin Locomotive Works—4-page bulletin No. 279 illustrates wide variety of uses that have been made of SR-4 bonded resistance wire strain gages. Listed also are various types of gages available for determining stresses and strains in structures and parts in service.

83. Lubricating Treatment

Parker Rust Proof Co.—12-page illustrated bulletin "Parco Lubrite" explains how this simple chemical treatment produces on wearing surfaces a nonmetallic, oil-absorbent coating that permits rapid break-in of moving parts without scoring or scuffing.

84. Nonferrous Castings

Atlantic Casting & Engineering Corp.—8-page illustrated booklet "Quality Castings at Production Prices" deals with facilities for making nonferrous castings. Mechanical and chemical properties of manganese bronze, yellow brass, silicon-aluminum alloy and aluminum bronze are listed also.

85. Link V-Belt

Manheim Mfg. & Belting Co.—24-page illustrated catalog entitled "Veelos, the Link V-Belt" presents advantages, applications and construction features of this belting. Methods of measuring and full engineering data are given also. Belting is adjustable to any length and adaptable to all types of drives.

86. Bearing Materials

Wel-Met Co.—4-page illustrated catalog No. 102 on self-lubricating bearing materials for experimental, emergency and small lot bearing requirements includes listings of solid and cored bars in all sizes up to 12 inches long and 2½ inches in diameter and 6 x 18-inch plates ⅛ to 1 inch thick.

87. Resin Compound

Goodyear Tire & Rubber Co.—36-page illustrated technical guide contains information on Pliolite S-5 high styrene-butadiene resin suitable for use in concrete floor enamels, acid and alkali resistant coatings, traffic marking paints, plaster sealers, aluminum finishes, silk screen inks and other compounds.

88. Mechanical Differential

Milwaukee Lock & Mfg. Co.—16-page illustrated booklet "Application of Small Mechanical Differentials to Instrument and Control Work" gives advantages of using precision mechanical differentials. Included are measuring and controlling of relative speeds, speed sums and speed differences, and controlling torques.

89. V-type Packings

C. W. Marsh Co.—6-page illustrated folder "Marsh Thermo Vee Packings" shows typical uses by means of cross-sectional drawings. Methods for determining packing height and size and other application data are given.

90. Cold Roll Forming

Yoder Co.—86-page illustrated booklet "Cold Roll Forming" discusses equipment and operations involved in process, end uses of its products and their advantages and possibilities. Auxiliary equipment for curving, coiling, ring forming, notching, perforating, welding, embossing, automatic cut-off and other operations are covered also.

91. Stainless Steel Fasteners

Allmetal Screw Products Co.—89-page illustrated catalog No. 49 covers complete line of stainless steel fasteners and presents useful engineering data pertaining to applications of stainless steel.

92. Small Motors

Electric Motor Corp.—4-page illustrated bulletin 3a-2a is entitled "EMC Fractional H.P. Motors for the 'Power Zone' of Your Product." Specifications are given on universal, series or shunt wound; shaded pole and direct current models. Details of gear reducers, fans and mounts for use with these motors are included.

93. Vibration Control

Korfund Co.—4-page illustrated catalog No. ER-701 lists applications of Elasto-Rib low cost cork and rubber mounting which requires no bolting or cementing. Three types of vibration dampers are described also with loading ranges from 40 to 1250 pounds per unit.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below.

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94. Pipe Coils

Crane Co.—48-page illustrated bulletin No. 318 contains comprehensive data on types of pipe coils, materials, pipe and accessories. Engineering information, typical coil applications and fabricating methods are covered.

95. Hydraulic Controls

Vickers Inc.—4-page illustrated bulletin 40-22 describes ¾, 1¼ and 1½-inch flow control and overload relief valves which provide accurate oil hydraulic volume control. These panel mounting units incorporate automatic pressure compensator and overload pressure relief adjustment.

96. Blind Rivets

B. F. Goodrich Co.—Slide type device shows operation of Rivnut one-piece blind rivet with inside threads. Fastener can be installed and headed from one side, can be used after enameling or painting, requires very small hole and forms compression fit.

97. Rubber

B. F. Goodrich Chemical Co.—8-page illustrated booklet "Hycar American Rubber" discusses properties and applications of special purpose vulcanizable rubbers which are available as dried sheets or latices. They provide excellent resistance to oil, abrasion, high temperature and aging.

98. Leaded Bronze Parts

American Crucible Products Co.—6-page illustrated pocket-size folder discusses use of Promet leaded bronze for axle bearings, journal liners, bushings and wearing parts for all types of coal mining equipment.

99. Color Selector

Arco Co.—Optonic Color Compass is device to simplify correct color selection, enabling user to utilize functional values provided by color in painting factories, mills, institutions and commercial buildings.

100. Precision Tubing

Precision Tube Co.—4-page illustrated folder "Precision Tubing for All Industry" describes characteristics of metal tubing from design standpoint, how it is made, tolerances maintained and alloys most frequently worked.

101. Visual Oilers

Gits Bros. Mfg. Co.—8-page illustrated bulletin "Gits Visual Oilers" describes complete line which includes constant level, gravity drip, sight feed and multiple feed types. These units lubricate automatically and economically.

102. Socket Screws

Holo-Krome Screw Corp.—24-page illustrated list price booklet No. 49 presents prices and data for standard and special sizes of all socket screw products manufactured by this concern.

103. Hard Rubber

American Hard Rubber Co.—4-page folder No. 101A discusses applications for Ace hard rubber and plastics and tabulates properties of hard rubber molded parts, sheets, rods and tubes.

104. Enclosed Safety Switches

Trumbull Electric Mfg. Co.—4-page illustrated bulletin TEC 302A gives factual information about type A style A heavy-duty industrial safety switches which are available in two, three and four-pole design in range of 30 to 1200 amperes.

105. V-Belt Drives

T. B. Wood's Sons Co.—96-page illustrated catalog No. 192 contains stock drive tables, engineering data and examples to aid in selection of proper Sure-Grip V-belt drive. Sections on special drives, sheaves, V-belts and general engineering information are included also.

106. Hydraulic Pump

Sundstrand Machine Tool Co.—Illustrated leaflet No. 131 deals with constant displacement hydraulically balanced pump which is available in sizes covering range of from 2 to 75 gallons per minute. It has volumetric efficiency of 90 per cent and mechanical efficiency of 80 per cent.

107. Resistors & Special Controls

Stackpole Carbon Co.—12-page illustrated engineering bulletin No. RC 7D covers insulated type fixed resistors available in ½ and 1-watt sizes, special resistors, variable resistors with and without line switch, and special controls.

108. Stamping Dies & Tools

Advance Die & Tool Co.—8-page illustrated bulletin "Simplify Your Production with Advance Tooling" shows and describes facilities and equipment for production of complicated dies and tools for difficult sheet metal drawing and forming operations.

109. Sprocket Chain

Hodell Chain Co.—4-page pocket-size folder "Precision Does It" describes sprocket chain which is made in range of sizes from 21-gage, running 82 links per foot, to 16-gage, running 34 links per foot, and with standard or high tensile strength links.

110. Tangent Benders

Struthers Wells Corp.—28-page illustrated bulletin No. T-1210 depicts operation and application of single wing, double wing, quadruplex and cam-operated double wing tangent benders. Various tangent-bent flanges and production facilities are portrayed also.

111. Electric Control Devices

Ward Leonard Electric Co.—8-page illustrated bulletin No. 100,000 presents details of complete line of electric control devices for industrial and commercial applications. Included are rheostats, resistors, relays, motor starters, contactors, control accessories and dimmers.

112. Thermostats

Stevens Mfg. Co.—Illustrated leaflet No. F-2002 deals with type C standard and hermetically sealed bi-metal strip thermostats which afford high degree of temperature stability as required by communications equipment, electronic devices and other electrical devices.

113. Instrument Motors

Holtzer-Cabot Inc.—4-page illustrated pamphlet "Instrument Motors" describes synchronous and induction types in ratings up to 1/500-horsepower. They are built with ball or sleeve bearings and with built-in gear heads that provide output shaft speeds to as low as 1 revolution per minute.

114. Air Valves

Gerotor May Corp.—20-page illustrated catalog section No. 301 depicts 21 different models in line of four-way air valves. Suitable for pressures up to 150 pounds per square inch, valves are shown in hand, foot, solenoid, cam and pilot types in sizes of ¼, ⅜, ½, ¾ and 1 inch.

115. Cast Iron Pulleys

Sprout, Waldron & Co.—16-page illustrated bulletin No. P-848 presents characteristics and prices of line of Blue Face pulleys which are available in diameters and face widths to meet most requirements. Also covered are Belt-Saver pulleys which are designed specially for rough service installations where hard abrasive materials must be handled.

116. Hydraulic Valves

Denison Engineering Co.—18-page illustrated technical booklet No. VD-2 presents data on ¾-inch HydrOlLic four-way valves which are hydraulically balanced directional controls for 2000-pound per square inch duty. They feature reinforced bodies and sliding spool action for directional control of oil flow.

117. Electric Plants

D. W. Onan & Sons Inc.—16-page illustrated bulletin No. A138 describes alternating current, direct current and battery charging models of electric plants which are available in ratings from 350 to 35,000 watts. All models are gasoline-engine driven and can be arranged for manual, semiautomatic and completely automatic operation.

118. Small Disk Clutches

Conway Clutch Co.—16-page illustrated bulletin D 345 on fractional horsepower disk clutches shows design features of these units which are available in 3, 4 and 5-inch sizes with single, tandem, triple and six-plate assemblies. They can be supplied also in double-throw arrangements.

119. Piston Packing Material

Darling Valve & Mfg. Co.—8-page illustrated bulletin form No. 4502 presents data on Darcova Pumcups which are precision-made composition cups for packing pistons of air and hydraulic cylinders, as well as reciprocating pumps. Made to tolerances of 0.005-inch, they fit cylinder or liner wall exactly.

120. Molybdenum Steel

Climax Molybdenum Co.—70-page illustrated booklet "Three Keys to Satisfaction" explains importance of good design in modern machinery and factors to be considered to achieve it, selection of proper heat treated alloy steel, and various operations which must be performed on steel in order to produce finished parts.

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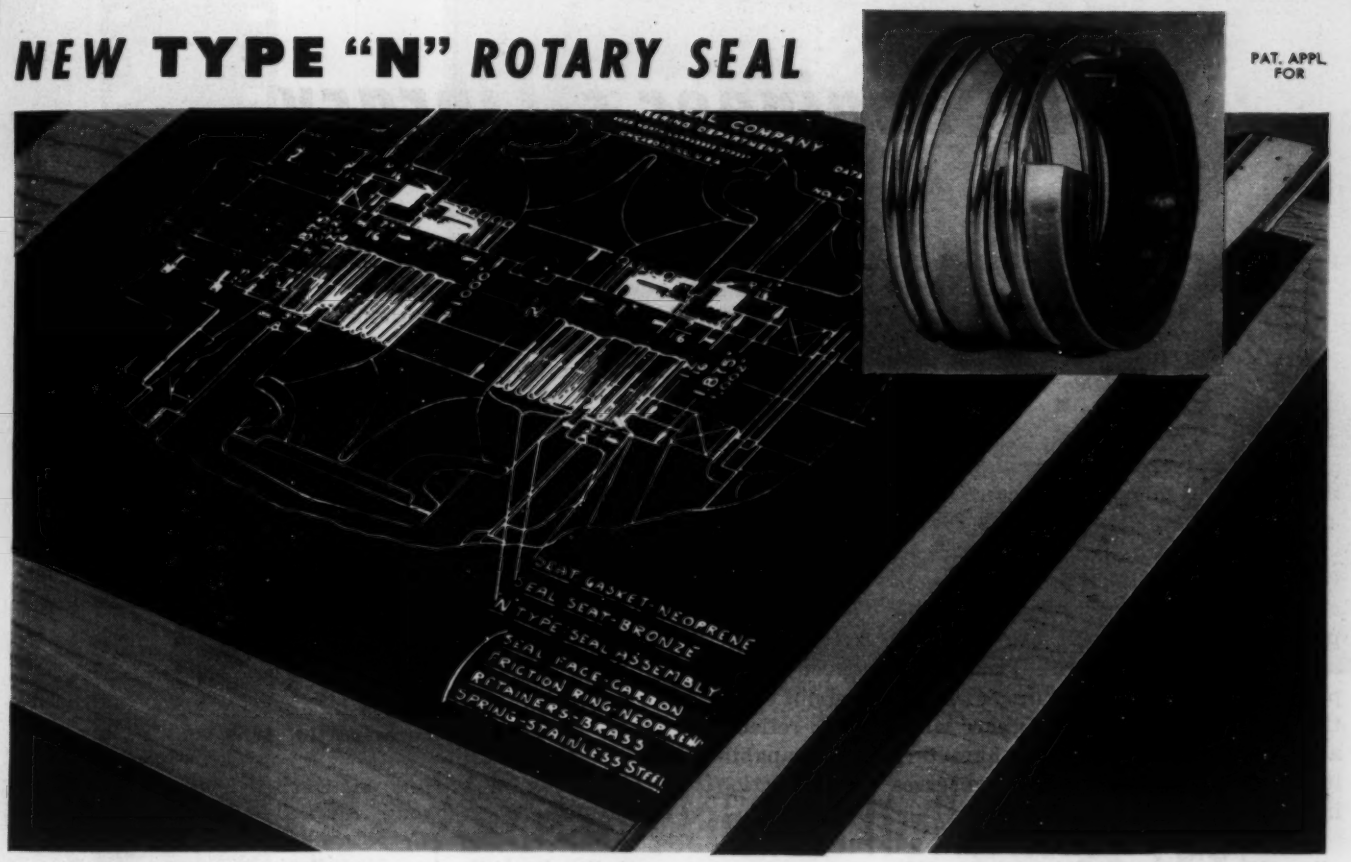

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The Engineer's Library

Production Processes . . . Their Influence on Design

By Roger W. Bolz, associate editor of MACHINE DESIGN; *published by The Penton Publishing Co., Cleveland, Ohio; 568 pages, 6½ by 10 inches, clothbound; available through* MACHINE DESIGN, $10.00 *postpaid.*

As machine-part production techniques become more precise, more highly specialized, faster and increasingly automatic, the need for matching the design of parts with the processes used in their production becomes an imperative. Much has been done to effect cost reductions through the development of improved production processes. But the greatest savings are those effected before production begins. These preproduction savings can be brought about only through the efforts of designers whose work reflects a keen appreciation of the character, scope, capabilities and limitations of the processes of production involved.

The problem, however, is how to put such an overall understanding into the mind of the designer. Few designers or students of design have ready access to intimate on-the-scene study of processes, and even those who have a background of shop experience have not worked with all processes.

To fill this great need, a truly significant book, *Production Processes . . . Their Influence on Design,* has been published by the Penton Publishing Co. Authored by Roger W. Bolz, associate editor of MACHINE DESIGN magazine, this book—a real "first" in its field—is based on a series of articles which have appeared in MACHINE DESIGN during the last four years. In that period, the response from machine designers throughout the country has clearly indicated that the information presented in these articles was of outstanding value.

Each chapter of this 568-page book deals intimately and in practical down-to-earth language with a single production process. All processes treated have been approached in a similar manner to permit a broad, fair analysis of each from the same design vantage point. First the process itself is described. Next, the machines employed in the process are discussed, including data on the range of work they can handle, their production rates, and significant features of their design and construction. Following this the author deals with how parts should be designed to permit optimum-speed, low-cost production of parts via the process, what materials are suited to fabrication by the process and, finally, the quality and accuracy of the surface finishes produced along with practical tolerances which can be held. In this manner the book covers thirty-six different processes which are subdivided into Metal Removal, Metal Forming, Metal Working and Forging, and Metal Deposition Methods. To bring firsthand practical everyday design practice and an intimate understanding of processing methods to the designer or student of production design, a wealth of illustrative material in the form of 652 photographs and drawings is used to point up the text.

With cost slashing pre-eminent in today's increasingly competitive market, this book comes at a most opportune time. By showing the designer how the parts he designs are actually produced, by acquainting him with the processes, and by showing him how to design specifically for production, it places in his hands the most potent of all tools for holding costs to rock-bottom levels.

□ □ □

Gas Turbines for Aircraft

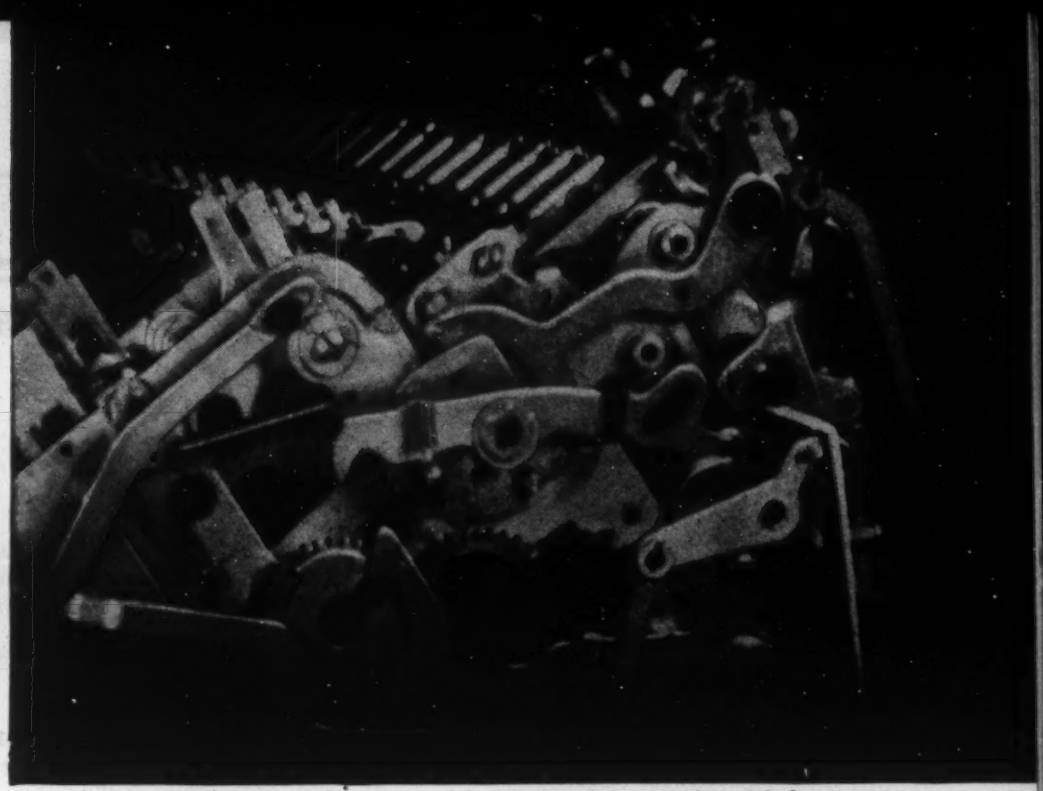
By F. W. Godsey, manager New Products division, Westinghouse Electric Corp., and Lloyd A. Young, Rand Corp.; published by the McGraw-Hill Book Co. Inc., New York; 355 pages, 6 x 9 inches, clothbound; available through MACHINE DESIGN, $4.50 *postpaid.*

Gas turbines are not new but their design was greatly advanced by the war stimulus, especially in the aircraft field. This renewed development effort prompted the author to make available to the engineers data on the progress made with the thought that such information might aid in further development.

Although specifically written for the aeronautical engineer and student, this book contains theoretical and experimental data of value to those interested in the gas turbine as a possible prime mover in the stationary and marine fields. The introductory chapters are good review for the aeronautical engineer and serve as informative material for other readers.

Beginning with Chapter 4, the author presents data of technical interest to all power engineers. Thermodynamic characteristics of compressors, fuels, burners, and turbines are discussed. Features of design are presented. Gas turbine cycles, variants of simple gas turbine cycles, aircraft-gas-turbine accessories and controls receive considerable attention. In conclusion, the author discusses the present development status of aircraft gas turbines. The appendix carries a graphic presentation of fuel and air data.

A second edition to *Welding Metallurgy,* covering to greater extent the steels employed by welding industries and how these alloys are affected by heat and stress, has been issued. Copies of the 505-page book may be purchased from the American Welding Society, 33 West 39 St., New York 18, N. Y., for $2.50.



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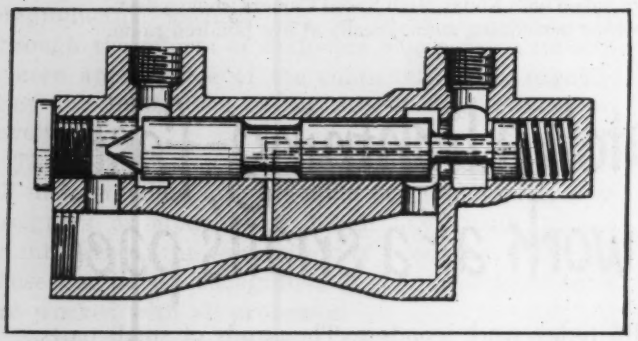
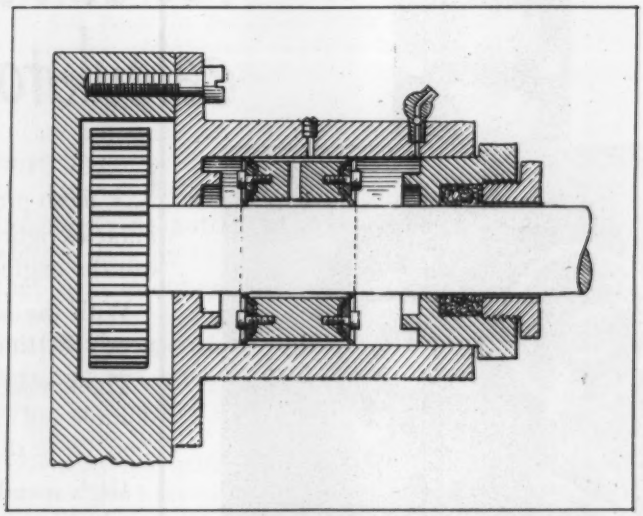
Noteworthy Patents

DIVIDED FLOW of fluid operating two or more hydraulic units from a common pump is effected by a fluid valve covered in patent 2,462,983. Pressure changes resulting from changing flow in the throat of a venturi section, in co-operation with a coil spring, actuate a valve to vary the fluid flowing to the various systems. If one system requires continuous flow, as in some hydraulic steering mechanisms, the entire pump output will be directed to that system until the pump output exceeds steering system requirements. As flow increases through the venturi, pressure drops at the throat. This pressure drop is transferred to the right-hand chamber which causes the valve to move to the position indicated in the figure. Since the division of fluid depends only on volume of fluid flowing through the venturi section, pressure variations in either system do not affect the operation of the other system. The valve can be adjusted for the amount of flow through the two branches by varying the size of the valve-actuating spring. Stanley I. MacDuff and Harold B. Schultz have assigned the patent to Bendix Aviation Corp.

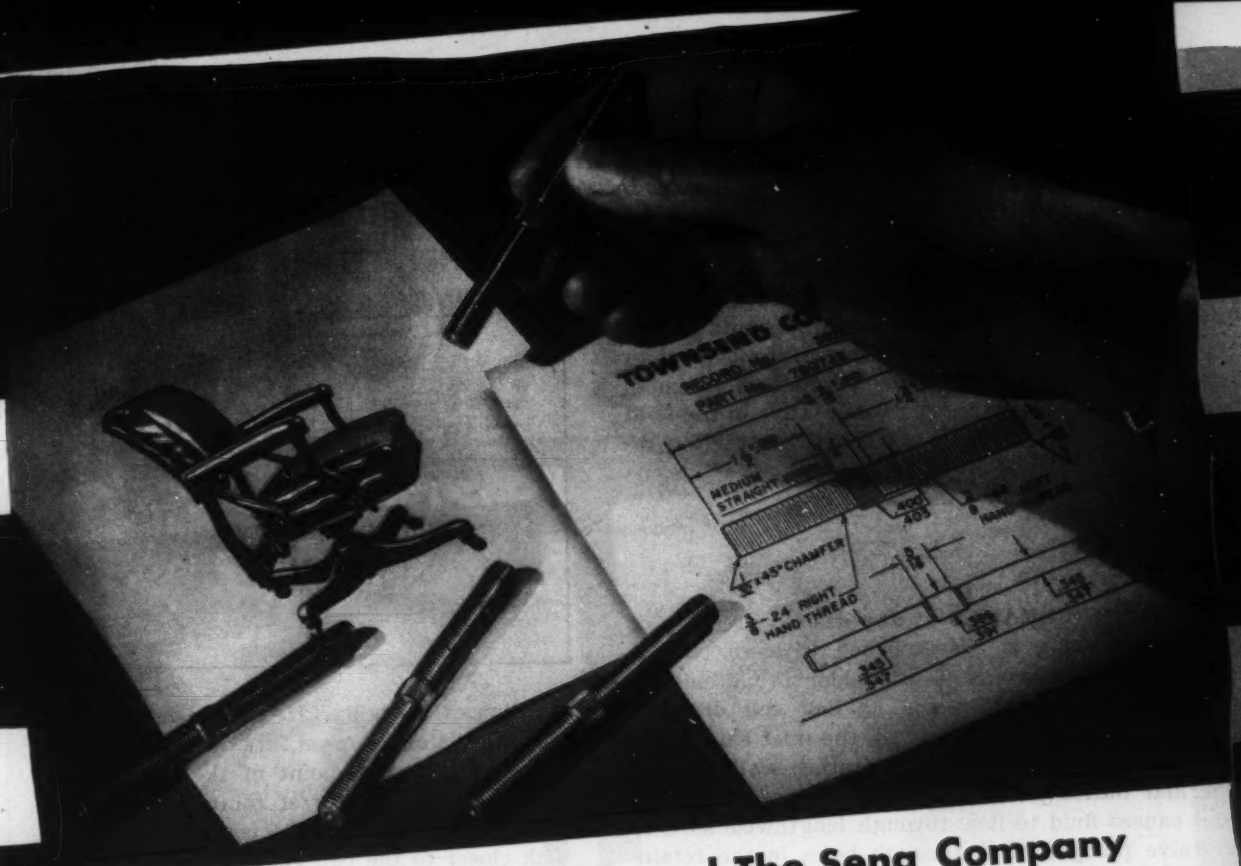


CONSTANTLY INCREASING TRACTIVE FORCE of an a-c solenoid as the plunger is drawn into the winding is accomplished with the improved magnetic circuit described in patent 2,468,052. Conventional a-c solenoids show a dip in tractive force at intermediate positions of the plunger, where a constant force is most generally needed. By locating the shading coil to preclude a flux botttleneck and designing the magnetic circuit to have a relatively low inductance in the withdrawn position, uniformly increasing change of inductance throughout the plunger travel is achieved, resulting in a constantly increasing plunger pull. Assigned to the Soreng Manufacturing Corp. by Hardin Y. Fisher.

REDUCED SHAFT WEAR on rotating equipment such as pumps results from the reed seal described in patent 2,459,654 and assigned to the Renniks Co. by Warren C. Kellogg and Ernest Hanshaw. The seal, made up of a series of interfitted, hollow, sheet-metal or comparable truncated-cone reeds, is allowed to bear on both stationary housing and revolving shaft and can rotate with the latter. Introducing grease under pressure on the low pressure side of the seal forces it to the extreme left side of its housing, leakage from the pump gradually forcing the seal to the right by displacing grease through the shaft packing. Surface speeds are reduced and, since the seal is allowed to travel axially within limits, the shaft does not become worn in one spot.



ACCURATE OPERATION under conditions of severe vibration or other movement is the purpose of the magnetic liquid level control mechanism described in patent 2,467,073 and assigned to Magnetrol Inc. by Benjamin L. Binford. A magnetic sleeve mounted on a float shaft or other actuating means



Here's How Townsend Saved The Seng Company $27.63 Per Thousand On One Cold Headed Part

This is an example of how a Chicago manufacturer, *who might have been you*, saved a large amount of money through the use of a Townsend cold headed part and thereby produced a better product for less money. The threaded adjusting screw (illustrated above) for the tilt back of the Seng action control for executive chairs is now being produced at Townsend by cold heading, knurling and roll threading for only $16.87 per thousand. The lowest price quoted for screw machine production was $44.50. This clear saving of $27.63 per thousand is important because Seng chair action control production is extremely high. Not only that, the Townsend part, being cold formed, is stronger than a part machined from bar stock and the roll threads are tougher and more uniform than machined threads. This gives The Seng Company an adjustment screw that works easily and helps produce a better chair at less cost.

This is not an isolated case with Townsend engineered parts and fasteners. It is typical of how Townsend helps save money and time by working closely with manufacturers in designing parts for many applications. Townsend parts and fasteners are cold headed, pointed, machined, drilled, slotted, trimmed, roll threaded, extruded, pierced, knurled, bent or flattened. They are produced in carbon, alloy and stainless steels—in brass, bronze, copper, aluminum—in a variety of platings and finishes.

To find out how to reduce costs and improve your products with Townsend cold headed parts send us a sample or sketch of the parts you need. Our engineers will gladly give you an estimate without obligation.

Call or write today to:

Townsend

COMPANY — ESTABLISHED 1816

New Brighton, Pa.

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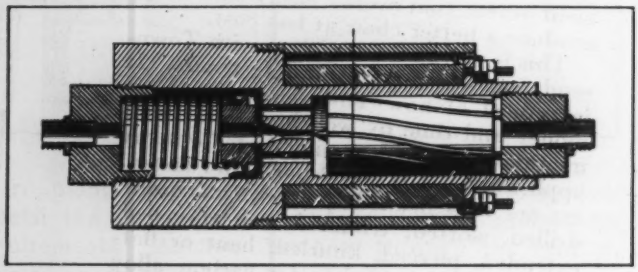
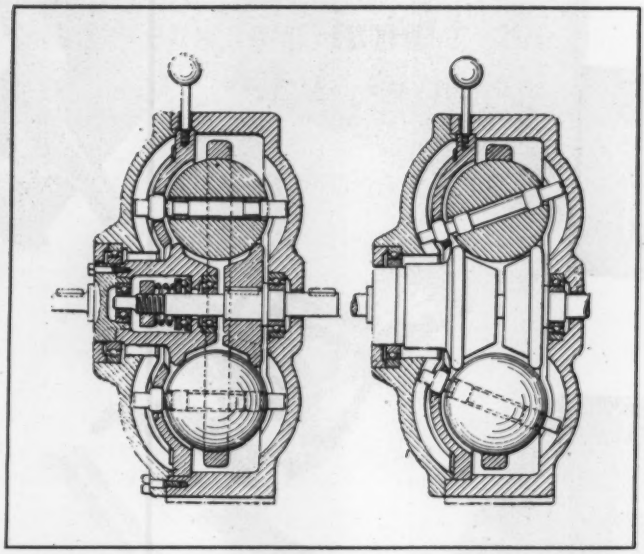
is free to travel vertically within a nonmagnetic tube. On the outside of this tube is a pivoted lever having small permanent magnets secured to either end. Changes in level of the liquid in the tank moves the magnetic sleeve up or down within the tube, attracting either the upper or lower end of the lever. Movement of the pivoted lever actuates microswitches to control the liquid level between desired limits. Since the length of the magnetic sleeve is greater than the distance between the two permanent magnets on the lever, the sleeve is therefore always in the field of at least one of the magnets. This construction results in stable operation since the lever is held in one position or the other by a magnetic force.

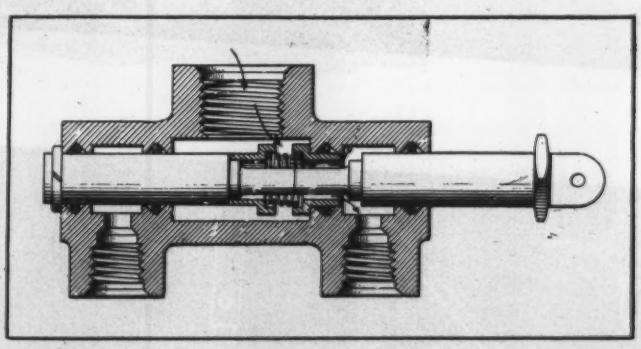
LOCKING OF BRAKES at any desired pressure or degree of braking is accomplished with an electromagnetic valve used as a hill-holder in automotive applications. Energizing the holding coil draws a plunger to the left in its bore on the inlet side of the unit, closing a valve in the separating wall between inlet and outlet passages. Actuation of the brake pedal causes fluid to flow through lengthwise slots in the valve plunger, then through holes in the retaining wall after displacing a spring-loaded rubber cup on the outlet side of the holes, and on into the individual wheel brakes. As long as the coil is energized and pressure has been applied to the pedal, the brakes remain locked, since the rubber cup prevents reverse flow through the ports and the valve is being held shut. De-energizing the coil opens the valve and permits fluid flow back past the plunger, thus releasing the brakes. Additional pressure can be transmitted to the brakes even though they are in the locked position and brakes will function normally if the holding coil is not energized. Patent 2,472,544 has been granted to Henry Nissen.



STEPLESS SPEED VARIATION in a unique speed-change gear is accomplished smoothly with a friction drive using adjustable, ball-shaped roller bodies. Contained within a freely-rotating encircling ring are five spherical friction members which are held against two spring-loaded drive rollers or disks, one on the driving and one on the driven shafts. As long as the axes of rotation of these friction balls are horizontal, the contact points of both friction disks with the rollers are at the same distance from the center of rotation of the balls. Hence, driving and driven disks turn at the same speed. Tilting the axes of the balls moves the contact point of the driving disk further away from the center of rotation of the balls and at the same time brings the contact point of the driven disk closer to the ball centers. The driven shaft now runs slower than the driving. Adjustment of the contact pressure between friction disks and balls, and therefore the power that can be transmitted, is made by adjusting a roller-bearing mounted compression spring mechanism on the driven shaft assembly. Since all axial forces are absorbed in the drive shaft and radial forces taken by the enclosing ball ring, no contact-pressure forces are transmitted to the rear casing. Patent 2,469,653 has been granted to Jean Kopp.



IMPROVED SEALING in high-pressure hydraulic valves with multiple flow paths is obtained with O-ring seals and two spring-loaded sleeves in the valve described in patent 2,469,921. As the valve stem is moved to the right, for example, the right-hand sliding sleeve first stops against the valve body. Further movement of the valve compresses the spring, separating the sleeve from its mating valve shoulder and permitting flow through the right port. The left section of the valve is effectively sealed by its O-ring seal until the valve is moved to the left. Seals are not exposed to the fluid flowing through the valve. George F. Hoge has assigned the patent to the Glenn L. Martin Co.

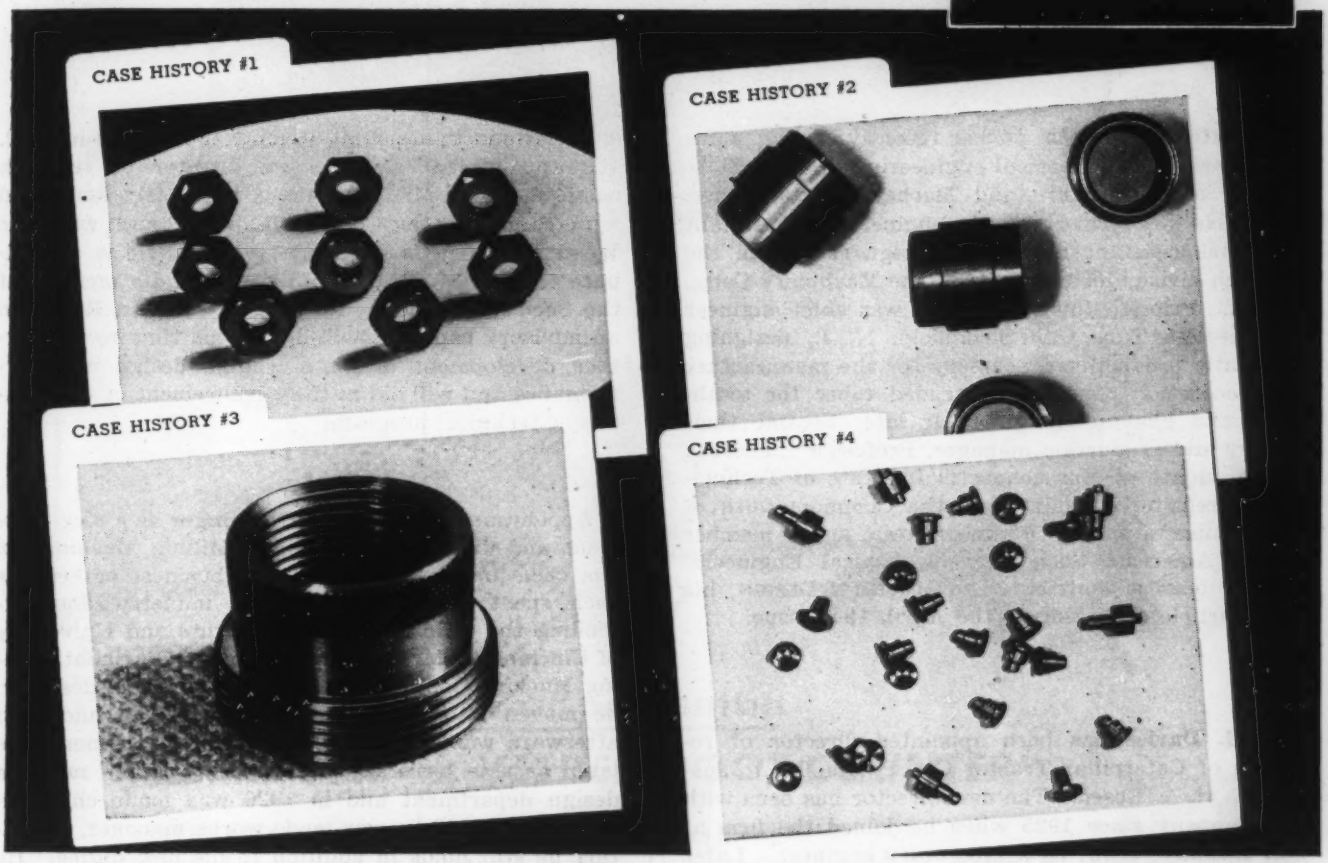


Four typical machine shops report

"LONGER TOOL LIFE"
"BETTER FINISH"
"FASTER OPERATION"
} *WITH NEW*

J&L *FREE-CUTTING* "E"* *STEEL*

J&L STEEL



Four typical examples, taken from 100 case histories, show superior machinability of J&L "E" Steel.

For 4 years before "E" Steel was publicly announced, this new, free-cutting bessemer screw stock was tried by independent machine shops throughout the metal-working industry.

More than 6,100 tons were tested in over 100 applications!

Here are quotations from 4 typical case histories:

CASE HISTORY #1 ". . . tool life increased 100% at normal speeds . . . better finish . . . shop people liked it."

CASE HISTORY #2 ". . . tool life increased up to 200% . . . uniformity of finish remained constant . . . considerably increased speeds without sacrifice to finish."

CASE HISTORY #3 ". . . tool life increased two to four times . . . we were able to tap 1" full internal pipe thread, almost impossible on regular material."

CASE HISTORY #4 ". . . new steel machines very well . . . finish excellent . . . tool life increased . . . 5 to 10% better production."

You too can get greater economies in your machining operations with new J&L free-cutting "E" Steel. "E" Steel is available in three grades: E-15, E-23 and E-33, each within the composition limits of the standard bessemer screw steels and with similar tensile properties. All standard sizes and shapes are available. For further information write for your copy of our new booklet: "J&L 'E' Steel."

Jones & Laughlin Steel Corporation
410 Jones & Laughlin Building
Pittsburgh 19, Penna.

Please send me a copy of "J&L 'E' Steel."

Name_____

Company_____

Address_____

JONES & LAUGHLIN STEEL CORPORATION

* "E" STEEL IS QUALITY-CONTROLLED FROM OUR OWN MINES THROUGH THE FINISHED PRODUCT

Men OF MACHINES

L. Sigfred Linderoth, Jr. has recently been appointed professor of mechanical engineering at Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa. He was formerly on the engineering consultant staff and assistant head of a design section in the research division of the United Shoe Machinery Corp., Boston. Prior to this position he was chief engineer for Peerless Tube Co., Bloomfield, N. J., designing automatic production machinery for the manufacture and decoration of impact extruded tubes for toothpaste and shaving creams. He later became their factory and production manager. Professor Linderoth is a graduate of Massachusetts Institute of Technology, a registered engineer in the Commonwealth of Massachusetts and the State of Iowa, and a member of the American Society of Mechanical Engineers. He has been a contributor to MACHINE DESIGN, his latest article appearing in the April, 1948 issue.

♦

J. M. Davies has been appointed director of research of Caterpillar Tractor Co., Peoria, Ill. to succeed **C. G. A. Rosen.** The new director has been with the company since 1925 when he joined the firm at San Leandro, Calif. as a laboratory engineer. Later he became a research engineer at San Leandro and was transferred in the same capacity to Peoria in 1933. In 1939 he was promoted to assistant chief engineer and to assistant director of research in 1942. His appointment as associate director of research came in 1945. Mr. Davies was previously associated with Standard Oil Co. in California and with the Western States Gas and Electric Co. He is a graduate of the University of California and a member of the Society of Automotive Engineers. Mr. Rosen, in an advisory capacity, will devote his time to the further development of diesel engine design and performance and will aid in the advancement of the company's technical program.

♦

Appointment of **Lester F. Nenninger** as a vice president and director of Cincinnati Milling Machine Co. has been announced. His entire business career has been spent in the machine tool industry since attending the Ohio Mechanic's Institute and University of Cincinnati. Mr. Nenninger came to Cincinnati Milling Machine Co. in 1912. Starting as a tool designer, he moved into the special service design and soon afterward was put in charge of that department. He later became assistant to the head of the machine design department and in 1926 was made chief engineer. In 1943 he was made works manager, a position he still holds in addition to his new duties. He is active in several engineering societies including the American Society of Mechanical Engineers, American Society for Metals, Army Ordnance Assn. and

L. Sigfred Linderoth, Jr.

J. M. Davies

Lester F. Nenninger

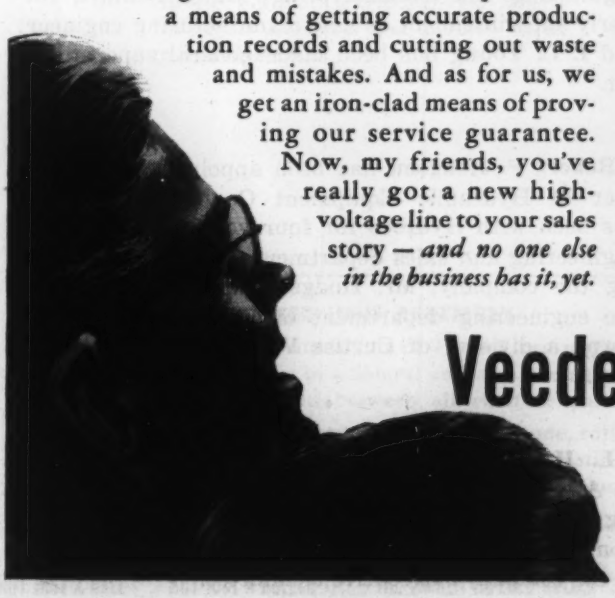
Brother Peddlers! . . .
Meet our New Star Salesman
. . . this built-in VEEDER-ROOT COUNTER*

LISTEN TO THIS SALES MANAGER: "First of the month, this counter goes into all our machines as standard, original equipment. This means *our customers get a new service* from our product—a means of getting accurate production records and cutting out waste and mistakes. And as for us, we get an iron-clad means of proving our service guarantee. Now, my friends, you've really got a new high-voltage line to your sales story—*and no one else in the business has it, yet.* Let's get going!"

That's an example of how "countless" products began to click faster in sales . . . *when they began to count.* For built-in Veeder-Root *Count*rol is a valuable extra service, a distinctive feature that talks business in the language of the toughest customer . . . *in plain, black-and-white figures.*

And these figures can be put to work in endless ways, for a poultry-physician or a map-maker, as the case may be. So why not for *you?* Don't say: "But my product can't count." Give it a chance to speak for itself . . . directly to *us.* Write.

*The Counter shown is a V-R Medium-Size Counter . . . about 4½" long, built into a long list of products to count strokes, turns, pieces, or what have you. It's one of scores of V-R counters shown in the 8-page condensed catalog. *Write for your copy.*



Veeder-Root COUNTERS

VEEDER-ROOT INC., HARTFORD 2, CONNECTICUT

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3. *In Great Britain:* Veeder-Root Ltd., Kilspindie Road, Dundee, Scotland.

Cincinnati Engineering Society. As a member of ASME he was one of the organizers of the Machine Design Division.

♦

Royal C. Bergvall

Royal C. Bergvall has been named engineering manager, industrial products division of Westinghouse Electric Corp., Pittsburgh. He has 28 years of engineering experience with the company, having served as assistant to the vice president in charge of engineering during the last eleven years. A native of Stephenson, Mich., he was graduated from the University of Michigan in 1921 with a degree in electrical engineering. After a training period on the graduate student course he was assigned to the general engineering department at East Pittsburgh where he worked until 1934. In that year he became engineering manager for the company's Middle Atlantic district with headquarters in Philadelphia. He returned to Pittsburgh as assistant to the vice president in 1938.

♦

J. E. Shepherd, engineering director for electron tubes, Sperry Gyroscope Co., Great Neck, Long Island, N. Y., has been elected president of the Technical Societies Council of New York, Inc. for the coming year.

♦

P. D. Tilton is now associated with Vickers Electric Division, St. Louis in the servomechanisms and systems group. Previous to this he was connected with Massachusetts Institute of Technology in the radiation laboratory from 1942 to 1945 and the servomechanisms laboratory from 1946 to 1949.

♦

Recent additions to the installation engineering section of Leece-Neville Co., Cleveland, include **John Post** and **William C. Leifer.**

♦

Appointment of **Oren G. Rutemiller** as chief engineer has been announced by Morton Manufacturing Co., Muskegon Heights, Mich. He will be in charge of all design engineering in connection with the Morton line of draw-cut machine tools and special machinery. Mr. Rutemiller received his engineering degree from the University of Cincinnati and has been associated with Westinghouse Electric Corp., the Crosley Division of AVCO Corp., and during the past several years has been consulting engineer for several machine tool and special machinery manufacturers in the Cincinnati area. He has been a contributor to MACHINE DESIGN, his latest article being published in June, 1948.

♦

Ross Gessford, formerly engineering specialist in cathode ray tubes, has been appointed chief engineer for the television picture tube division of Sylvania Electric Products Inc., Seneca Falls, N. Y.

♦

Superior Steel Corp., Pittsburgh, announces the appointment of **S. S. Rickley** as chief engineer. A graduate of Carnegie Institute of Technology he has served in various capacities in the engineering department since November, 1945.

♦

Bruce Copping, formerly chief engineer of the Coca Cola Co., has been made executive vice president and general manager of Atkron Inc., Cuyahoga Falls, Ohio. Atkron is the manufacturer of the RCA uncaser and washer-loader. Mr. Copping is associated in the Atkron Co. with his brother, **Brian Copping,** formerly chief engineer of Raymond Loewy Associates.

♦

W. E. Jacobsen has been appointed assistant manager of General Electric's federal and marine engineering division, Schenectady, N. Y.

♦

Baker Industrial Truck Division of The Baker-Raulang Co., Cleveland, announces several recent organization changes. **John A. Matousek** has been named manager of manufacturing; **E. H. Remde,** formerly works manager, has been appointed to the newly created post of advisor to the president on engineering and manufacturing; **H. A. Schultz,** formerly superintendent, is now manufacturing engineer; and **I. L. Young** has been made general superintendent.

♦

Robert F. Hodgson has been appointed chief engineer of Hydraulic Equipment Co., Cleveland. He has been with Hydreco for four years serving in the engineering and sales departments. Prior to his joining the company, Mr. Hodgson was connected with the engineering department of Wright Aeronautical Corp., a division of Curtiss Wright Corp., Paterson, N. J.

♦

L. H. Flora has been named chief engineer and **R. A. Hartman** was made manager of field engineering of Tinnerman Products Inc., Cleveland. In addition both Mr. Flora and Mr. Hartman were appointed to the company's executive committee.

How TIMKEN® bearings help keep vibration out of railroad axle lathes

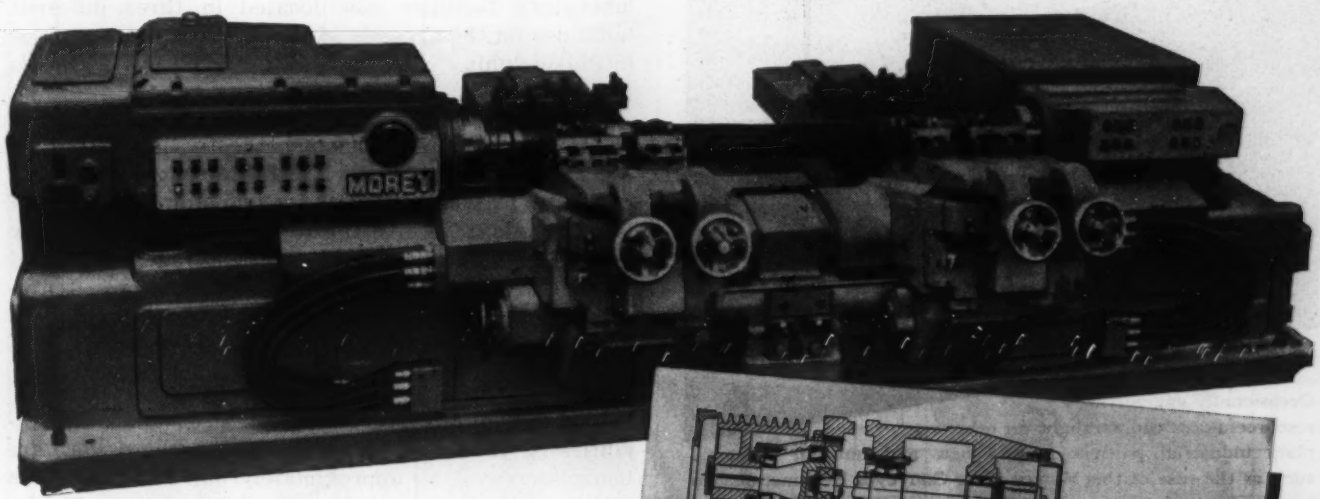
THE Morey Automatic Railroad Axle Lathe is designed to rough or finish turn railroad axles in two to three minutes. The extreme rigidity of this 58,000 lb. machine, plus the use of Timken® tapered roller bearings throughout the headstock, makes possible multiple tooling with tungsten carbide tools at maximum efficiency and assures smooth, vibration-free turning of even the most eccentric forgings. The main spindle drive is designed to transmit 150 H.P. in continuous duty, allowing for momentary overloads up to 225 H.P. Close tolerances are constantly maintained during finish turning.

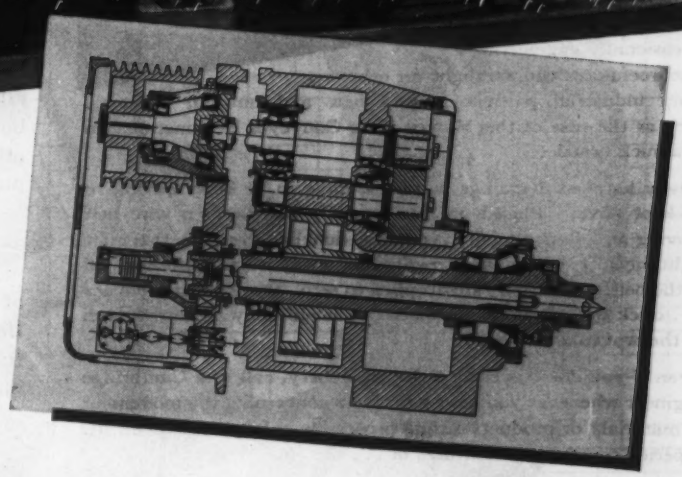
The tapered construction of Timken tapered bearings enables them to carry the lathe's 50,000 pound thrust load, plus radial loads, without end-play or deflection. Headstock shafts are held in rigid alignment and all possibility of chatter is eliminated.

Power loss is minimized because Timken bearings have true rolling motion for frictionless operation. Timken bearings are made of special analysis Timken fine alloy steel and are manufactured to almost incredible limits of accuracy. Quality is constantly and rigidly controlled.

No other bearing can give you *all* the advantages you get with Timken tapered roller bearings. Whether you build a machine or buy it, always look for the trade-mark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





The **MOREY MACHINERY CO., INC., ASTORIA, N.Y.,** *uses 9 Timken bearings in lathe headstock to keep shafts and spindle in perfect alignment and to carry 50,000 pound thrust load.*

GENERATED UNIT ASSEMBLY

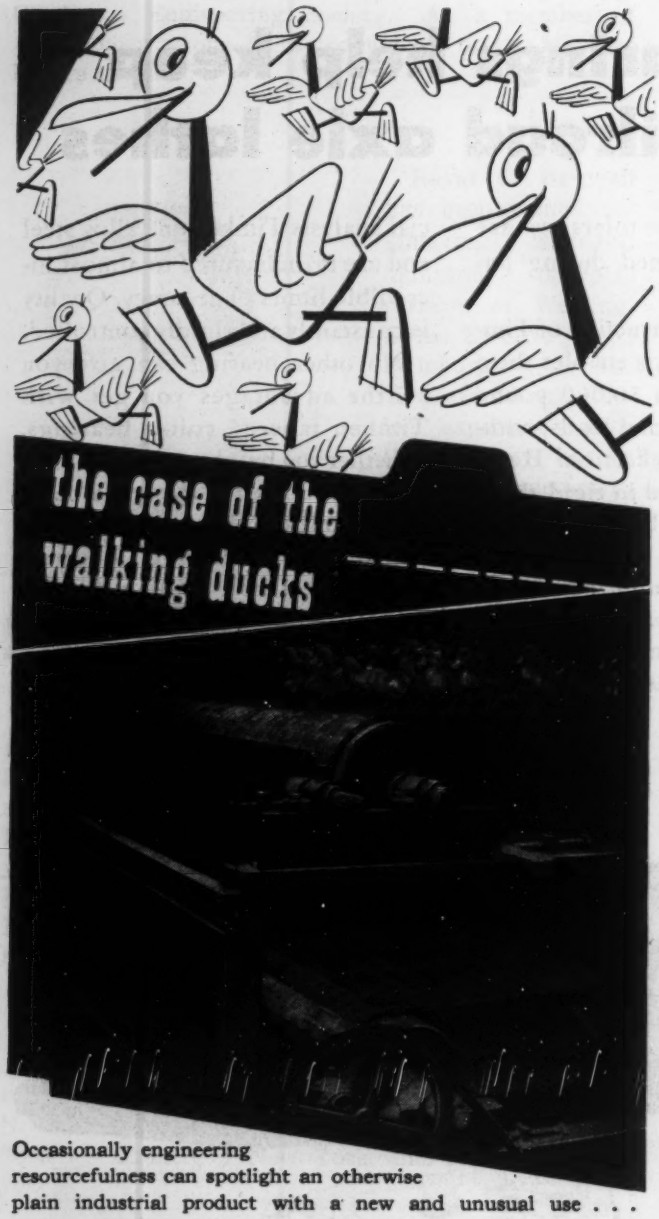
An extra step in the manufacture of Timken bearings—after assembly—results in a natural and true geometric contact being generated between all rotating parts. This perfect mating of the component parts—cone, rolls and cup—assures positive roll alignment, long lasting precision, permanent adjustment and smooth operation.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION →✳←



Occasionally engineering resourcefulness can spotlight an otherwise plain industrial product with a new and unusual use . . . such as the case of this Woven Wire Conveyor Belt installation in a duck brooder.

Newly hatched ducklings, it seems, have to be kept moving to be kept alive. Placed on this specially built woven wire belt moving at a slow rate of speed, the ducklings remain there for eight days . . . continually treadmilling away from the falling end of the belt. Mortality rate dropped to zero. By-product recovery . . . duck droppings for fertilizer . . . is aided by the open mesh of the woven wire belt.

Even if you don't operate a duck hatchery, call in a Cambridge engineer whenever you have a problem concerning the movement of materials or products during processing. Let him explain the superior construction features of . . .

CAMBRIDGE Woven Wire Conveyor Belts

This illustrated 130 page catalog—FREE—to men concerned with production control. WRITE TODAY.

Cambridge Wire Cloth Co.

Department N • Cambridge 9, Maryland

NEW YORK • BALTIMORE • PITTSBURGH • SAN FRANCISCO
BOSTON • DETROIT • CHICAGO • ST. LOUIS • HOUSTON

News of Manufacturers

A $1,690,637 contract to erect the main laboratory and office building for the **Westinghouse Electric Corporation's** Atomic Power Division at the Bettis Field site in Pittsburgh, Pa., has been awarded to **Ragnar Benson Inc.,** Chicago, Ill. In this project, Westinghouse is working under contract with the Atomic Energy Commission and in co-operation with the Argonne National Laboratory, major center of the Commission's "nuclear reactor" development program.

♦

Construction work has started in Philadelphia on the Marshall Laboratory of the **Du Pont Company.** Scheduled to be completed late next year at a cost of $2,000,000, the new four-story building will replace laboratory facilities now located in three different buildings on the grounds of the Du Pont finishes plant in Philadelphia.

♦

At a cost of over $500,000, the former four-story Margo St., Los Angeles, Calif., warehouse is being completely reconditioned and a two-story brick annex is being added to give the **Keuffel & Esser Company** a total of 40,000 sq ft of plant, storage, office and retail store space. October 1, 1949 has been tentatively set as the date on which the firm will enter its new location.

♦

The present manufacturing, research and office facilities of **Landis Machine Co.,** Waynesboro, Pa., are being increased by approximately 50,000 sq ft. This addition to the present floor space is coupled with the purchase of a number of new machines and tools.

♦

Federal-Mogul Corp., Detroit, Mich., manufacturers of automotive engine bearings, have acquired the **National Formetal Company** of Cleveland, O., manufacturers of rolled split bushings. The latter will be operated as a division of Federal-Mogul Corp.

♦

Hamilton-Thomas Corp., Hamilton, Ohio, has announced the acquisition of **The Smith & Mills Co.,** Cincinnati, Ohio, manufacturers of crank shapers. To be known as The Smith & Mills Division of Hamilton-Thomas Corp., the former Cincinnati company will produce its line of shapers at the Hamilton plant of the parent corporation.

♦

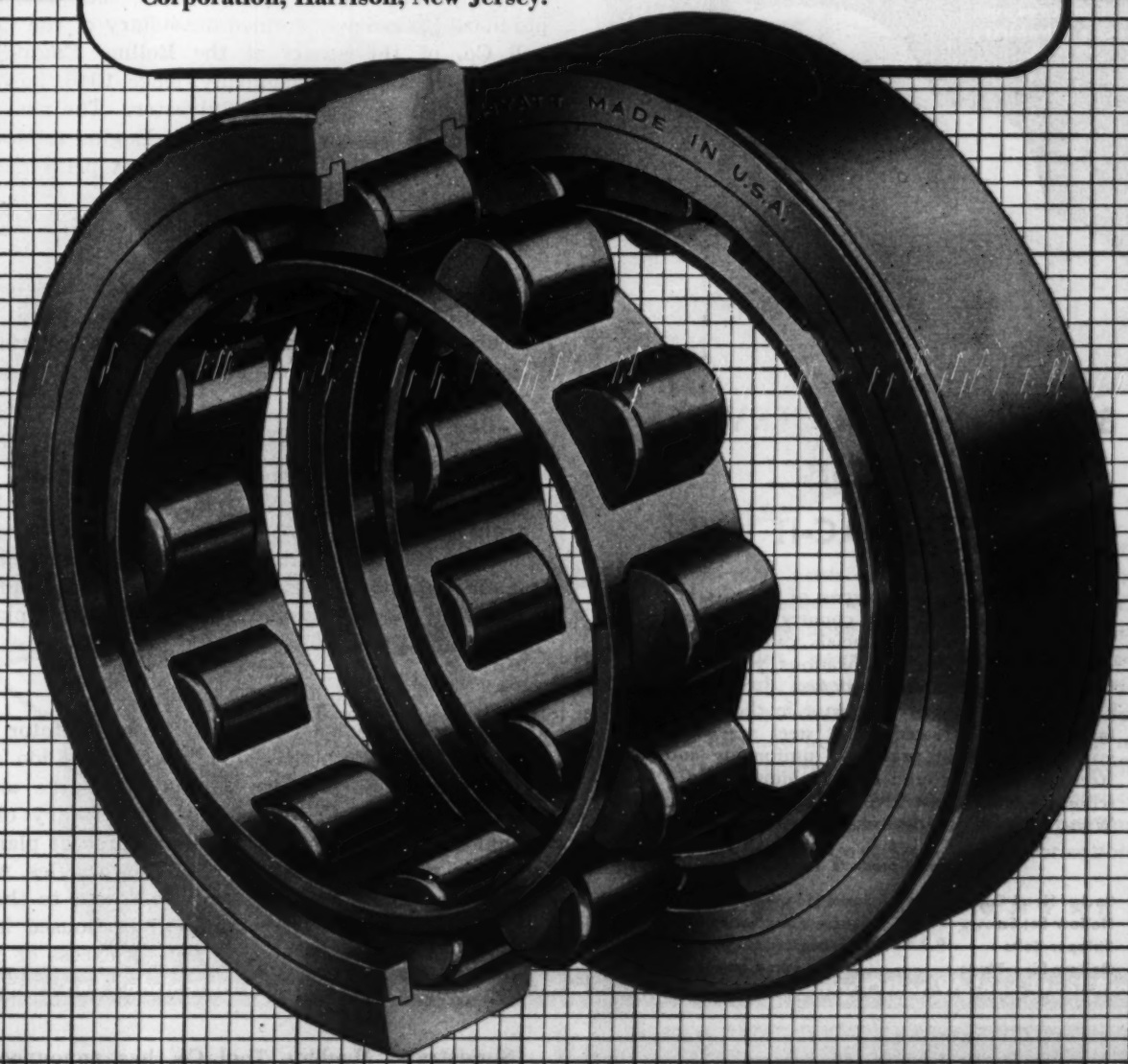
The management of **The Federal Machine and Welder Co.** has announced that it will consolidate the operations of the Warco Press Div. and the Welder Div.

Designed in . . . for life

The straight cylindrical construction of Hyatt Roller Bearings permits radial loads carried by the bearing to be evenly distributed over the entire length of the rollers. The larger area of contact between the load carrying elements in straight cylindrical bearings results in greater bearing capacity and longer life with less maintenance.

Size for size, Hyatt Hy-Load Roller Bearings offer maximum radial load carrying capacity. They are "designed in" for the life of your equipment.

To get the most out of the equipment you build, sell or buy, be sure that it is equipped with Hyatt Roller Bearings. Let us tell you more about what we can do for you. Write to Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.



HYATT ROLLER BEARINGS

in its Plant No. 2, located on Overland Ave. just beyond the city limits of Warren, Ohio. Originally built and tooled for the manufacture of medium tanks, Plant No. 2 since the war has been engaged in the manufacture of resistance welding equipment, press brakes and other types of special machinery. It is fully equipped to handle the machining, assembly and testing of the Warco lines of presses.

♦

Rogers Corp. and **Bakelite Corp.** have announced the termination of their toll agreement under which Rogers, with plants in Goodyear and Manchester, Conn., manufactured a group of high-strength thermosetting phenolic materials for Bakelite. Rogers will continue to produce the same plastics materials it made under the toll agreement, but will merchandise them through its own Plastics Division. Simultaneously, Rogers announced the expansion and integration of its materials and services.

♦

A. S. Campbell Co. Inc., Boston, has announced purchase by a newly formed subsidiary of the Campbell Co. of the assets of the **Rollins Engine Co.,** Nashua, N. H. This company, since 1946, has been owned solely by Russell L. Sylvester. The new company will be known as the Rinns Engine & Machine Co. Inc. and will maintain its present plant and organization at Nashua.

♦

The Cambridge Wire Cloth Company has erected an additional bay at their Cambridge, Md. plant. Built especially to house the company's wire fabrication department, the addition has a floor area of 18,000 sq ft.

♦

A chlorinated benzene producing plant has been placed in operation at Natrium, W. Va. by the **Pittsburgh Plate Glass Co.** Under construction for more than a year, the plant adjoins a large chlorine and caustic soda producing facility constructed during the early war years. Esimated cost of the new plant is more than $1,000,000.

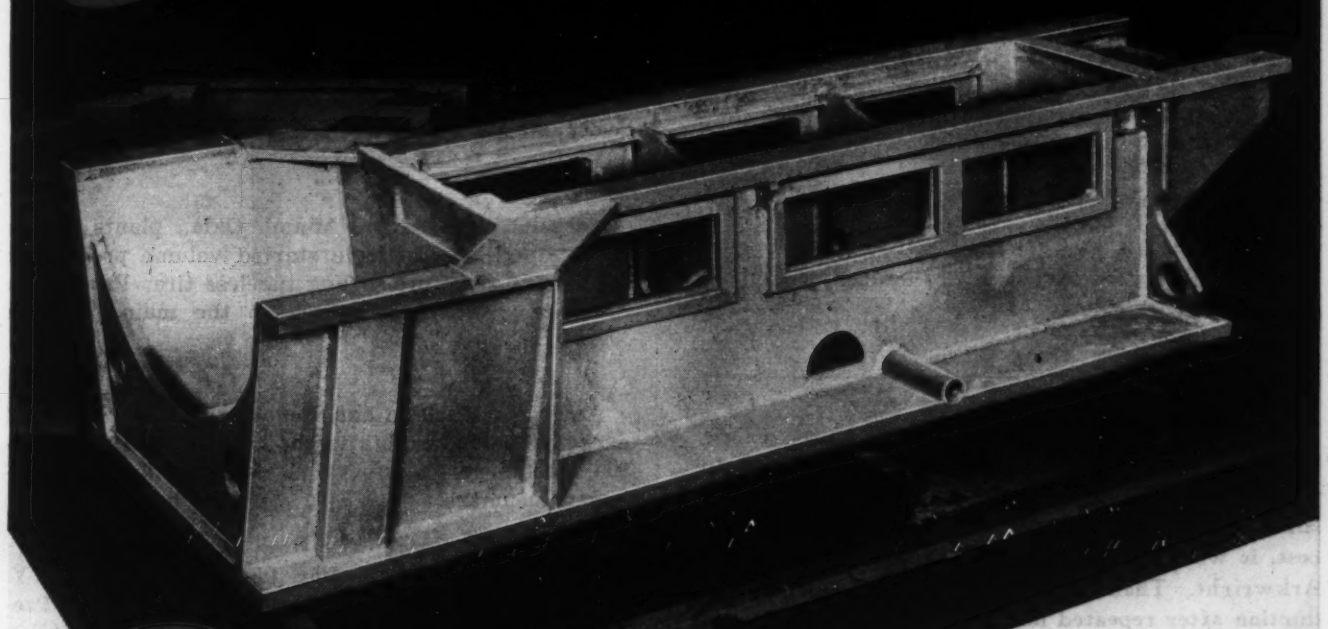
♦

Contracts have been signed by **National Motor Bearing Co.** for the erection of a new half-million dollar **Arrowhead Rubber** plant on an eight-acre site at Downey, Calif. Arrowhead is a subsidiary of National Motor Bearing. Arrowhead's present plant, located in the industrial section of Los Angeles, will be abandoned and all operations transferred to the new plant in Downey. The plant will be housed in two structures with an aggregate area in excess of 62,000 sq ft.

♦

Sundstrand Machine Tool Co. has announced the purchase of the **Rockford Magnetic Products Co.,** located at 9th Street and 18th Avenue, Rockford, Ill. As a subsidiary of Sundstrand, the company will be operated under the name of Sundstrand Magnetic

Steel-Weld FABRICATION



More and more machinery parts and assemblies are being produced in welded steel form. This diesel engine base is typical. In your manufacturing activities, need will arise for a good source for Steel-Weld Fabricated parts. The Mahon organization invites your inspection of its complete facilities for Steel-Weld design engineering, production, and rough or finished machining. A source ready to serve you well, regardless of what your requirements may be . . . a source from which you may expect a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

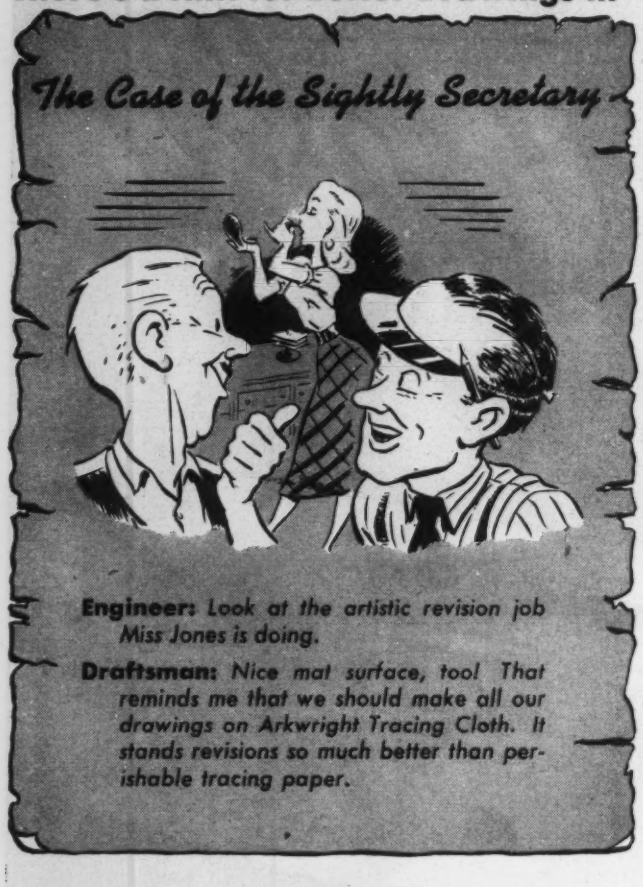
THE R. C. MAHON COMPANY

Detroit 11, Michigan

Engineers and Fabricators of Welded Steel Machine Bases and Frames, and Many Other Welded Steel Products

MAHON

There's a Hint for Better Drawings in—

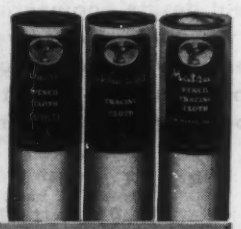


Revision means little to Arkwright Tracing Cloth. It stands up without wearing through and re-inks without feathering. Its translucency is built in from surface to surface. For only a thrifty trifle more in cost, it will pay you to make *all your drawings* on Arkwright. Then you can count on perfect reproduction after repeated handling or years of aging in the file.

See for yourself how much better Arkwright serves. Sold by leading drawing material dealers everywhere. Generous working samples on request. Arkwright Finishing Company, Providence, R. I.

The Big Six Reasons Why Arkwright Tracing Cloths Excel

1. Erasures re-ink without feathering.
2. Prints are always sharp and clean.
3. Tracings never discolor or go brittle.
4. No surface oils, soaps or waxes to dry out.
5. No pinholes or thick threads.
6. Mechanical processing creates permanent transparency.



ARKWRIGHT
TRACING CLOTHS
AMERICA'S STANDARD FOR OVER 25 YEARS

Products Co. and will continue in its present location the manufacture of its line of magnetic holding devices which include standard chucks for grinders, shapers, milling machines and lathes; lifting magnets; hand separators and special holding fixtures.

♦

N. A. Strand & Co., 5001 North Wolcott Ave., Chicago, has been acquired by the **Balmer Corp.** of Baltimore, a wholly-owned subsidiary of **Franklin Railway Supply Co.**, 60 East 42 St., New York City. Operating as a division of the Balmer Corporation, Strand will continue to manufacture the Strandflex line of flexible shaft machine tools.

♦

The Schauer Mfg. Corp. is the new name of the company formerly known as the **Schauer Machine Co.** Located in Cincinnati, Ohio, Schauer manufactures a complete line of speed lathes for finishing operations, bench grinders, battery chargers, battery eliminators, rectifiers, and automotive test instruments.

♦

Tuscaloosa, Ala., and Miami, Okla., plants of the **B. F. Goodrich Co.** have started volume production of the new puncture-sealing tubeless tire. Production previously had been limited to the main plant in Akron, O.

♦

American Machine and Foundry Co., has obtained exclusive selling rights in the United States for textile machinery manufactured by **Titan, Ltd.**, Copenhagen, Denmark.

♦

Arwood Precision Casting Corp., Brooklyn, N. Y. has purchased the precision casting facilities of **Precise Castings Corp.**, division of The Cooper Alloy Foundry Co., Hillside, N. J.

♦

Stainless steel wire in rounds ½-inch and finer and certain size flats will be manufactured by a new mill of **American Steel and Wire Co.** designed specifically for the purpose and located in Waukegan, Ill.

♦

Watch-Motor Mainspring Co. Inc. of New York City has changed its name to **Sandsteel Spring Co. Inc.** They manufacture watch mainsprings and at present are expanding their industrial-spring field.

♦

Lenkurt Electric Co., San Carlos, Calif., manufacturer of carrier equipment for wire-line and radio-link communication, electrical wave filters and toroidal coils, has announced the incorporation of a Canadian subsidiary company with its plant located at 926 Hastings St., Vancouver B. C. Manufacturing and assembly operations will be carried on there by the subsidiary company, Lenkurt Electric Co. of Canada, Ltd.

IT'S ALL FOR THE GOOD OF SIRVIS...

THE BOIL TEST

Boiling would be rugged treatment for any steer. But, for Sirvis steer*hide* it's a must. The boil test, which is more severe than either dry heat or hot oil tests, determines heat resistance, measured by shrinkage. Because of Sirvis tanning processes, shrinkage under the boil test is usually less than 1%. Sirvis' reaction to the test is demonstrated by two pieces of buff grain steerhide, identical in quality and dimensions. After boiling in the same container for thirty minutes, one piece, an ordinary vegetable tanned leather, was hard, curled and shrunken, as shown in the photograph. The Sirvis chrome retanned piece shrank only 0.7% . . . retained its natural flexibility, strength and texture . . . and its resistance to heat was thereby accurately determined.

This is just one of the many laboratory controlled tests to which Sirvis leathers are subjected . . . so that you may be assured of top quality in packings, boots, gaskets, diaphragms and other mechanical leather products. Because of extreme care in designing, excellence of materials, and constant checks in production, Sirvis mechanical leathers are outstanding in dependability.

• *For detailed information about Sirvis products, write for the free Chicago Rawhide catalog.*

OTHER C/R PRODUCTS
PERFECT Oil Seals
SIRVENE Synthetic Rubber

MECHANICAL LEATHER PRODUCTS

sirvis

CHICAGO RAWHIDE MANUFACTURING COMPANY

1304 Elston Ave., Chicago 22, Illinois

New York • Philadelphia • Detroit • San Francisco • Cleveland • Boston
Pittsburgh • Los Angeles • Cincinnati • Minneapolis • Syracuse • Peoria

When you design for uniform product performance . . .

specify

Cramer

TYPE SX
SYNCHRONOUS MOTORS

The Cramer Type SX Synchronous Motor is a superior power plant designed for applications requiring a constant speed at a given frequency. Widely used throughout the instrument and control fields, the Type SX is a highly efficient permanent magnet type motor . . . producing an exceptionally high torque of 30 in. oz. at 1 RPM, 60 cy.

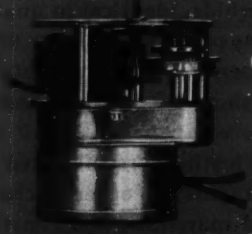
Close tolerance of magnetic field construction and precision alignment of gear train, assure long, uninterrupted service at low cost. Self-starting, the Type SX reaches synchronous speed within ½ to 2 cycles . . . stops within one pole of motion on 240 RPM rotor shaft (1/60 sec.). Standard gear trains range in speeds from 60 RPM to 1/14 RPM . . . available for 25, 50 and 60 cycle operation.

For compactness, flexibility, accuracy and uniform timing performance . . . specify the Cramer Type SX Motor.

ADAPTATIONS OF TYPE SX MOTOR

CHART DRIVE TYPE

With heavy duty supplementary gear train. Sixteen output shaft speeds ranging from 2 RPM through 1 rev. in 10 days. Can be equipped with 2-way friction clutch or anti-backlash gearing.



CLUTCH TYPE

With differential clutch . . . designed for time delay relays or any type of timing mechanism requiring resetting operation. Wide variety of speeds.

REVERSIBLE TYPE

Shaft operates in either direction, permitting three combinations . . . 2 speeds forward, 1 reverse . . . 2 reverse, 1 forward. Wide range of speeds.

SEND FOR BULLETIN 108

THE R. W. CRAMER COMPANY, INC.
Box 6, Centerbrook, Conn.

9CR49

Lens Grinder

(*Continued from Page 90*)

raising the spindle is a pneumatic cylinder. The bottom spindle rapidly rises to within a few thousandths of an inch of engaging the work with the grinding wheel and, at the same time, the flow of coolant is started.

At this point the slow feed takes effect by braking the motion with a hydro-check. The rate of the slow feed is controlled by metering the oil in the hydro-check through a flow control valve. As the bottom spindle comes against the stop it trips a Microswitch which in turn operates a time-delay relay. This relay determines the amount of time or dwell the lens has at the stop to allow the grinding wheel to clear itself or 'spark out' as it is commonly termed in the metal grinding field.

Completes Cycle Automatically

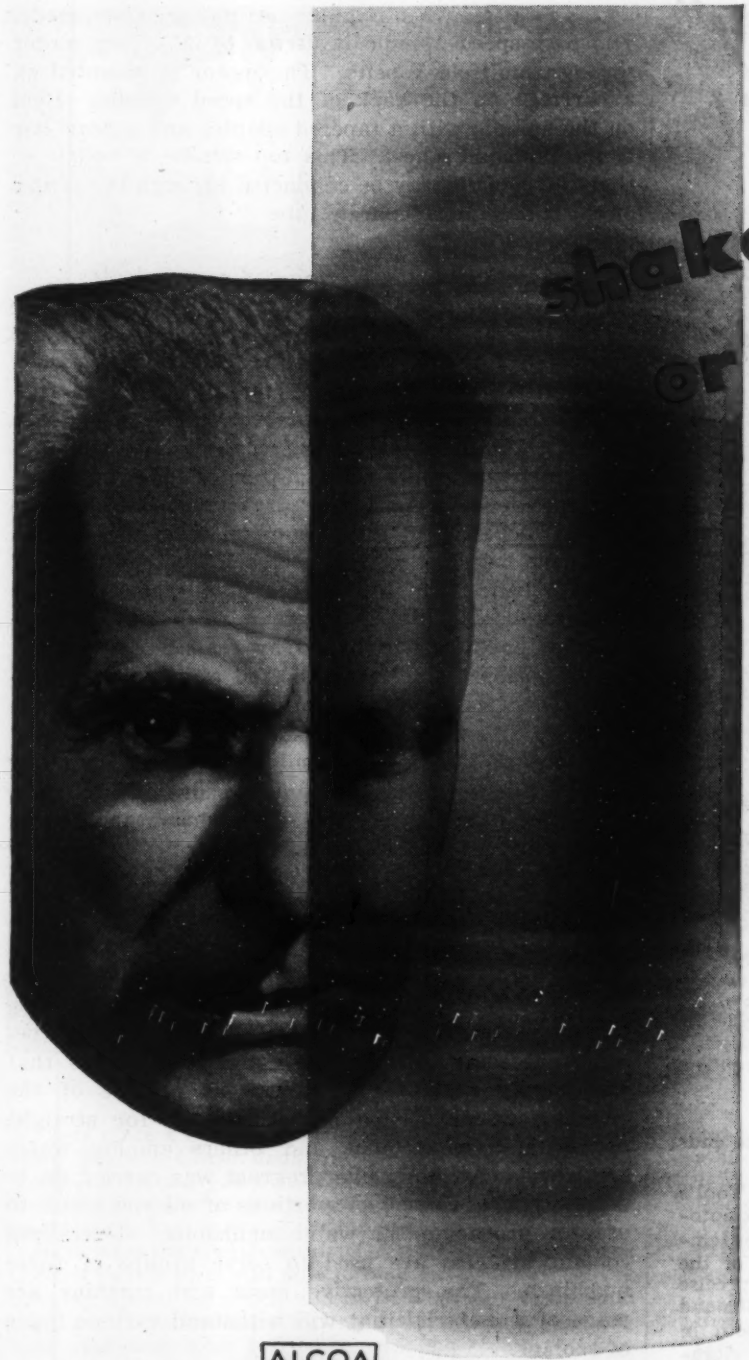
At the end of the dwell time the bottom spindle returns to the unload postion shutting off the coolant flow and stopping its rotation. The finished blank is then removed from the chuck and a new one put in its place and the cycle started again. The length of the cycle varies from 10 to 21 seconds, depending on the size of the lens and the amount of glass to be removed.

Running at 6800 rpm, the top spindle is controlled by a separate start and stop switch. An emergency stop button is provided which shuts down the entire machine and drops the bottom spindle to its down position no matter where in the cycle of operation the machine may be.

Base of this machine is cast iron and has thick-walled sections. Also, to add stability and freedom from vibration, the base is well ribbed. An effort has been made to eliminate all flat surfaces to discourage the deposition on the machine of any articles such as rags, tools, gages or anything detrimental to the safety of the operator or the general orderliness of the plant. Also, toe room has been built in so that operators may stand close to the machine with comfort and incidentally not mark or mar the machine by rubbing the tips of their shoes against the finish.

Bearings Are Sealed for Life

Sealed and lubricated for life, the high-speed upper spindle is an antifriction quill type unit. The first models of this machine were equipped with a visible type of oiling system. Further investigation, however, showed that it was more economical to use a sealed and lubricated-for-life type of high-speed spindle. This spindle is clamped in a housing and may be moved along its axis if necessary when radical changes in setup are made. The spindle housing may be rotated about an axis normal to its own axis. A draw bar holds the housing against its seat



shakedown... or breakdown?

Vibration. Compound stresses. The drag of inertia. Every one going up algebraically as cycles mount. You can relax, if high-speed reciprocating parts are Alcoa Forgings. Their aluminum *lightness* cuts inertia, saves power, smooths vibration. Their forged *strength* withstands shocks and stresses. Their *uniformity* lets you predict performance.

Add corrosion resistance, fast heat transfer, easy machinability... and you'll see why designers pick Alcoa Forgings for high-speed parts. It's worth investigating. Our forge shops are ready to tackle your problem. Just mail the coupon below, or call your nearby Alcoa Sales Office.

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I would like to have full information on the advantages of aluminum forgings for the following application:

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Name_____ Position_____

Company_____

Address_____

SHEET & PLATE · SHAPES, ROLLED & EXTRUDED · WIRE · ROD · BAR · TUBING · PIPE · SAND, DIE & PERMANENT MOLD CASTINGS · FORGINGS · IMPACT EXTRUSIONS
ELECTRICAL CONDUCTORS · SCREW MACHINE PRODUCTS · FABRICATED PRODUCTS · FASTENERS · FOIL · ALUMINUM POWDERS · MAGNESIUM PRODUCTS

"Smooths the way" for AIR ... or OIL

In all of Monarch Machine Tool's lathes with "Air Gage Tracer", Resistoflex assemblies are used to assure smooth, split-second hydraulic gaging and control. For they proved to be the only lines to live up to required performance.

Once again Resistoflex hose ends a line problem.

In Monarch Machine Tool's method of duplicating work automatically, gaging of a master template is done through the medium of air. Because of the sensitivity of the "Air Gage Tracer," unrestricted, precise air flow is *imperative*. In addition, the line must withstand continuous flexing. Monarch finds the answer to both in Resistoflex hose. Not only is it immune to flexing and vibration, but, with its glass-smooth compar tube, it allows full air flow without any turbulence!

Of course, if you use *oil* as a medium, you're also concerned about hose-deterioration and clogging. But you needn't ever worry on that score either with Resistoflex lines. Impervious to hydraulic fluids, these non-sloughing lines assure *clean, smoothly working* circuits at all times.

Do you have a line problem? Discover how you can transmit oils or gases through fatigue-proof Resistoflex lines and reduce servicing. Write us about it.

RESISTOFLEX
CORPORATION
Belleville 9, New Jersey
SYNTHETIC FLEXIBLE PRODUCTS AND PARTS FOR INDUSTRY

and is loosened when angular settings are to be made. The high-speed spindle is driven by a 1½-hp motor through multiple V-belts. The motor is mounted on a carriage on the back of the speed spindle. Held on the spindle with a tapered adapter and a draw bar is the diamond wheel. This top spindle is hollow so that the coolant may be conducted through the center of the spindle in a separate tube.

Drive Has Telescoping Countershaft

Also of the antifriction quill type and sealed and lubricated for life, the lower work-carrying spindle is driven through a pair of spiral bevel gears running semi-immersed in lubricant. The gears are driven through a telescoping countershaft equipped with universal joints so that it may follow the bottom spindle as it makes its traverse. The countershaft is actuated by a motor mounted in the base on a floating carriage and connected to the countershaft by a V-belt. The top of the spindle is protected from the coolant by a slinger and a bellows and the rotating parts are protected by seals.

The bottom spindle may be fed either by the controlled traverse of a pneumatic cylinder or by a gravity feed. In either case the pneumatic cylinder is used to bring the work into contact with the grinding wheel. Employed for constant-pressure grinding, the gravity feed makes possible feeds slower than those obtainable with the hydro-check control.

Coolant Supplied Through Hollow Spindle

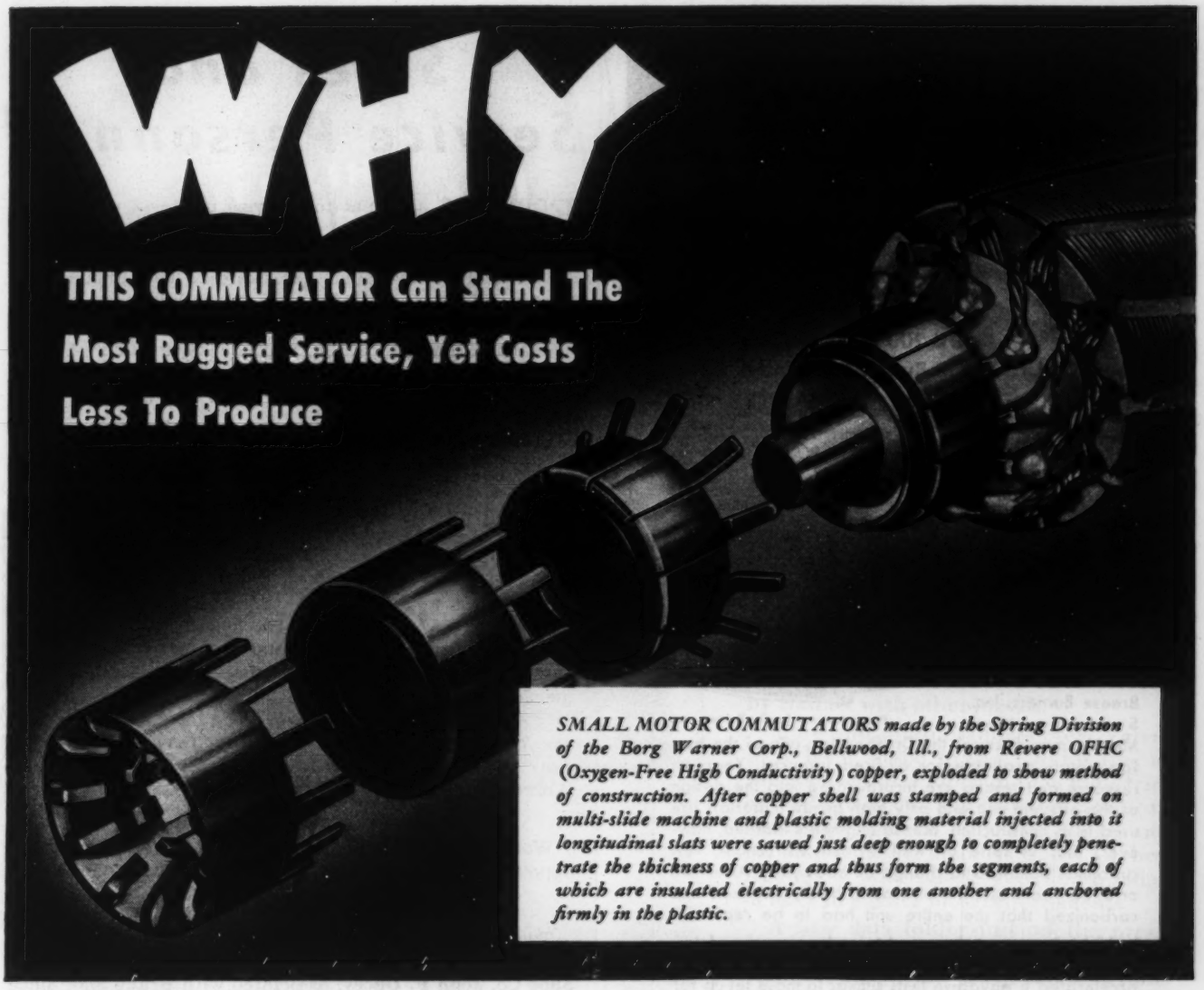
In general, on normal sizes of work, it is satisfactory to supply the coolant to the work through the center of the grinding spindle. On large work it becomes necessary to add an extra coolant line that will supply coolant onto the work outside of the grinding wheel. Some operations call for straight petroleum type coolant and others employ water emulsions. An extensive program was carried on to determine the correct proportions of oil and water to use for preparing the water emulsions. Centralized coolant systems are used to serve groups of these machines. The protective seals and curtains are made of a material that will withstand various types of coolant.

Discussion of this machine would not be complete without a word about the care used in assembly. All mounting surfaces are scraped, and dial indicators, graduated to tenths of thousandths of an inch, are used to make measurements. If any motion can be detected on these indicators the parts are reworked. Alignment of the top and bottom spindles must be such that their axes lie in the same plane and remain so no matter what the angular setting of the top spindle.

This spherical generator is only one of several special machines in use or being built to process lenses in the Bausch & Lomb plant. With the elimination of loose abrasive, the way is now open to make the ophthalmic lens manufacturing plant extremely clean, precise and safe according to all modern plant conceptions.

WHY

THIS COMMUTATOR Can Stand The Most Rugged Service, Yet Costs Less To Produce



SMALL MOTOR COMMUTATORS made by the Spring Division of the Borg Warner Corp., Bellwood, Ill., from Revere OFHC (Oxygen-Free High Conductivity) copper, exploded to show method of construction. After copper shell was stamped and formed on multi-slide machine and plastic molding material injected into it longitudinal slats were sawed just deep enough to completely penetrate the thickness of copper and thus form the segments, each of which are insulated electrically from one another and anchored firmly in the plastic.

IT was quite a complex problem the Spring Division of Borg Warner Corp. dropped into the lap of Revere's Technical Advisory Service. They were getting set to manufacture commutators for small motors and they wanted to select the best material for the job.

Here were the specifications: The material had to be the hardest possible yet still able to take the extremely severe forming operation which was to be done in a multi-slide machine. High hardness was necessary in order to combine maximum wear resistance with the ability to withstand the extreme centrifugal force developed in small motors operating at high speeds. In addition, in the molding operation, which is done after the copper shells have been formed, it was necessary to hold the diameter of the shell to within .001" in order to prevent the plastic from flowing between the mold and the outer surfaces of the commutator. An equal tolerance was also imposed upon the height of the solid cylindrical portion for the same reason. Also of great importance was the need for the cylinder wall being almost absolutely flat.

Because of long experience with somewhat similar problems Revere recommended trial of OFHC (Oxygen-Free High Conductivity) copper, four numbers hard. This was tested along with several other metals. The OFHC alone was found to produce excellent parts, and with tolerances so close as to be almost unbelievable in this type of operation. All other types of copper failed at the very sharp bend where the anchoring lugs join the side of the shell.

An unusual feature of these commutators is the plastic material used in the core. Tough, and unusual in composition, it serves both as insulation and as a mechanical connection between commutator and shaft without use of a bushing and key.

To determine if these commutators could *really* take it, test motors in which they were used were speeded up to 35,000 rpm. Although the wiring in the rotors practically exploded at that speed, there were no failures in the commutators, Temperature tests up to 400° F. were also made. Here again there was no damage to the commutator, though the rotor wiring was badly damaged due to the combination of centrifugal force and decrease in wire strength. Once again the unusual combination of properties of Revere OFHC copper had played a part in helping another one of the country's leading manufacturers produce an outstanding product at less cost.

Perhaps this or some other Revere Metal can be of help in improving your product—cutting your production costs. Toward that end we suggest that you get in touch with your nearest Revere Sales Office.

REVERE

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.

DC Silicone News

NO OIL CHANGE FOR 5 YEARS!

DC 200 Silicone Fluid Adds Years Of Life To Oil Burner Fan Motors

Bearings of the BREESE DRAFBOOSTER oil furnace fan motor are lubricated with DC 200 Silicone Fluid to give years of satisfactory maintenance - free service.

Photo courtesy Breese Burners, Inc.

Breese Burners, Inc., Santa Fe, New Mexico, manufactures the Drafbooster, one of the best fan motors available for oil-fired furnaces. Years of research and testing are incorporated into the design of this efficient unit and only high grade materials are used in its construction. Breese engineers learned, however, that in spite of well written instructions, few customers bothered to change oil each year. After two or three years' use, the oil was so badly oxidized and carbonized that the entire unit had to be replaced.

In 1944 Breese engineers obtained a sample of low viscosity DC 200 Silicone Fluid and subjected it to accelerated breakdown tests similar to those set up for testing the mineral oils Breese had been using.

M. D. Huston, Mgr. Sales Engineering for Breese, had this to say about the breakdown testing: "To our great surprise, the silicone fluid worked perfectly and showed no signs of oxidation or other deterioration. We immediately put Drafboosters containing DC 200 on lifetime field tests under the most severe operating conditions. A recent check of one unit which has been working since 1944 revealed the DC 200 Silicone Fluid is still just as good a lubricant as when it was put in. In August 1948, we standardized on DC 200 Fluid for all our Drafboosters."

DC 200 Silicone Fluids are widely used as damping media, as hydraulic fluids and as liquid dielectrics. For more information about the properties of these remarkable fluids phone our nearest branch office or write for our 32-page booklet 20-M8.

DOW CORNING CORPORATION
MIDLAND, MICHIGAN

Atlanta • Chicago • Cleveland • Dallas • Los Angeles • New York
In Canada: Fiberglas Canada, Ltd., Toronto
In England: Albright and Wilson, Ltd., London

Dow Corning FIRST IN SILICONES

Sales and Service Personnel

FORMERLY assistant to the vice president of Hydraulic Equipment Co. and sales and development engineer, **Norman J. Paquin** has formed his own company for the distribution of hydraulic accessories. The Paquin Co., located at 145 East 192nd St., Cleveland 19, O., represents various manufacturers, including U. S. Gauge Co., Sellersville, Pa.; Aeroquip Corp., Jackson, Mich.; L. and L. Mfg. Co., Detroit; Capital Engineering and Mfg. Co., Chicago; and Trimount Instrument Co., Chicago.

♦

The appointment of **Grant E. Scott Jr.** as assitant sales manager has been announced by Klipfel Valves Inc., a division of Hamilton-Thomas Corp., Hamilton, O. Mr. Scott will serve as assistant to **Frank Breor,** sales manager of the division.

♦

Chain Belt Co. of Milwaukee, manufacturers of chain and transmission, conveying and process equipment, has appointed **Charles Pingry** district sales engineer for the Dallas, Tex. office. Mr. Pingry has been in the factory organization of Chain Belt for almost two years and has had considerable practical experience in the company's shops and offices at Milwaukee, Springfield and Worcester.

♦

Working out of Chicago, **E. Palmer Meredith** has been appointed district sales engineer for the V & O Press Co.

♦

Two new district sales managers have been appointed for the Brake Shoe & Castings Div. of American Brake Shoe Co. **John F. Ducey,** associated with Brake Shoe since 1936, is located at the company's New York office, and **Sam R. Watkins,** a veteran of ten years with the company, is in the Cleveland sales office.

♦

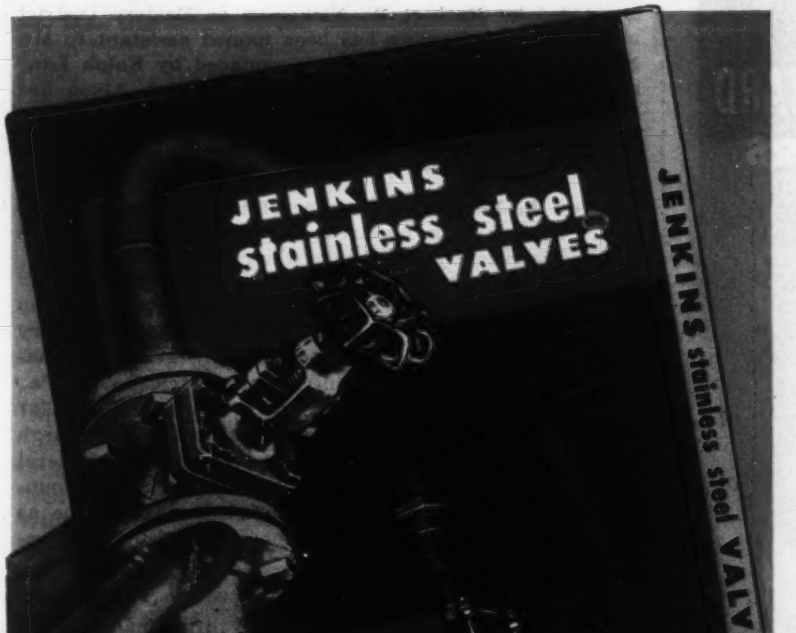
Charles E. Anderson was recently appointed district sales representative of the Sprague Electric Co., North Adams, Mass. Mr. Anderson will be responsible for the sale of Sprague capacitors, resistors, and other electronic components to equipment manufacturers in Ohio, West Virginia, western Pennsylvania and northern Kentucky. His offices are at 4500 Euclid Ave., Cleveland, O.

♦

The board of directors of Worthington Pump and Machinery Corp. has elected **John J. Summersby** to the position of vice president in charge of sales. Mr. Summersby has been with Worthington's sales staff since 1919, having joined the company three years before that. In addition to this appointment, Worthington has named **Thomas J. Kehane** assistant vice president and general sales manager. Mr. Kehane has also held various positions in the sales department since first becoming affiliated with the company in 1915.

♦

The Fellows Gear Shaper Co. has announced the following changes in its sales organization: **Cecil M. Peter** has been made vice president and general manager with headquarters in Springfield, Vt. **Leroy C. King** has become sales manager with headquarters in New York and is



Built to the same quality standard that makes any Jenkins Valve your best buy.

You know it pays — and pays well — to use Jenkins Bronze, Iron and Steel Valves. In industry after industry, these valves bearing the famous Diamond trade-mark have set records for long, trouble-free service and low upkeep cost.

You'll find the same Jenkins quality built into Jenkins Valves of Stainless Steel. Service records show many years of faultless operation in the control of highly corrosive fluids, and liquids which may become contaminated or discolored by contact with other metals.

More and more Stainless Steel Valves have been added to the Jenkins line as the need has developed in such industries as food processing and packing, chemical, textile, petroleum, pulp and paper, and rubber. Today it includes Gates, Globes, Angle, "Y" and Check Valves in a range of sizes to answer most requirements.

A new data folder just off the press, describes the complete line of Jenkins Stainless Steel Valves, and contains valuable information on selection of the proper alloy for the service.

If your plant handles corrosive liquids, or fluids that must be kept absolutely free from contamination or discoloration, you will want this new Data Folder. Ask for Form 194. It will help you select the right Stainless Steel Valve for your requirements. Write for a copy today.

Jenkins Bros., 80 White St., New York 13; Bridgeport, Conn.; Atlanta; Boston; Philadelphia; Chicago; San Francisco. Jenkins Bros., Limited, Montreal, Canada.

Sold through industrial distributors.

Here's the story of the

COMPLETE LINE

of

JENKINS Stainless Steel VALVES

JENKINS

LOOK FOR THE DIAMOND MARK

VALVES

SINCE 1864 TRADE JENKINS MARK

Jenkins Bros

because the shape is elliptical

When space is at a premium, the elliptical (hence, stronger) shape of STRIPOHM Resistors gives high unit-space rating and extra strength to withstand electrical and mechanical strain.

These vitreous enameled wire-wound resistors have low mounting brackets . . . strategically arranged terminals permitting multiple stacking for further saving of space . . . no sharp edges. Ratings from 30 to 75 watts . . . 0.45 to 66,000 ohms.

Write for Bulletin 23. WARD LEONARD ELECTRIC COMPANY, 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

succeeded by **Herbert W. Nickerson** as Eastern District manager. **Fred Pauling** has been named assistant to Mr. Nickerson in New York and is replaced by **Ralph Lane** as representative in the Boston area. **Ralph Aiken** has taken over the Syracuse territory formerly served by Mr. Lane.

♦

Leroy A. Johnson, a member of the Chicago Vitreous Enamel Product Co. research division for the past twelve years, has recently been made a service engineer.

♦

Recently elected president of Pittsburgh Steel Foundry Corp., **Thomas F. Dorsey** was formerly general manager of Fort Pitt Steel Casting division, McKeesport, Pa., since it was purchased by the corporation in 1945. In 1947 Mr. Dorsey was named vice president of Pittsburgh Steel Foundry Corp. and a year later became general manager of the Fort Pitt, as well as Glassport, Pa. foundry, also operated by the company. He will continue as general manager of the corporation, with offices in Glassport and McKeesport.

♦

The appointment of a new Chicago office manager has been announced by Plastic and Rubber Products Inc., Dayton, O. **Harlan H. Davis,** for the past three years chief hydraulic engineer of Dunbar Kapple Inc., has replaced **Robert E. Allen** in this position. Mr. Allen has transferred his activities to the Dayton office.

♦

With headquarters in San Francisco, **John P. McArthur** has been appointed manager of West Coast sales for the Worthington Pump and Machinery Corp. He will supervise the activities of the Los Angeles, San Francisco, Seattle, and Salt Lake City district offices.

♦

George Smith has been named New England representative for Rogers Corp., Manchester, Conn. manufacturers and fabricators of fibrous insulating and structural materials. Mr. Smith was previously in the experimental test group at the Pratt and Whitney Div. of United Aircraft Corp., East Hartford, Conn. and had also been a sales engineer for Kenneth Thomas Co., Hartford, Conn.

♦

Sales engineer for Snyder Tool & Engineering Co. since 1944, **William D. Pomeroy** has been appointed sales representative for New York, New Jersey, New England and Pennsylvania. Mr. Pomeroy will make his headquarters at 65 Cayuga St., Seneca Falls, N. Y.

♦

An industrial salesman with General Electric Co. for many years, **C. J. Rowles** has been elected vice president of Euclid Electric & Mfg. Co., Madison, O.

♦

A. P. Fleming has been chosen to fill the newly-created position of sales manager for the Reynolds Metals Co. The assistant sales manager, **F. W. Allsmiller,** has been transferred from New York to Louisville, and **J. W. Macauley** has been assigned to the Philadelphia and Pittsburgh territories, with headquarters in Philadelphia.

♦

District engineer since 1935, **E. E. Goehringer** has assumed sales and engineering responsibility in the Indianapolis area as district manager for the Lincoln Electric Co. The Indianapolis office is located at 3343 Central Ave. It has also been announced that **Omer Blodgett**

has been transferred to the Lincoln Chicago office at 2450 South Prairie St. In addition to his duties as a sales engineer, Mr. Blodgett has a special assignment in the Chicago area in engineering applications for redesigning to welded steel fabrication. Also, **R. L. Hall** and **Robert Hirsch,** district engineers, have been assigned to the company's office at 22 Wabash St., Pittsburgh, Pa.

♦

Recently appointed district manager by the Carpenter Steel Co. is **Avard W. Taylor,** who was formerly assistant manager. Serving the Philadelphia and Reading, Pa. territories, Mr. Taylor is located at 3701 North Broad St., Philadelphia, Pa.

♦

The Pennsylvania Flexible Metallic Tubing Co. has recently announced several changes in sales personnel. **William Townsend,** for many years sales manager, has been made vice president in charge of sales. **Don W. Williams,** formerly manager of the company's Los Angeles branch, has been named Cleveland manager, and **C. F. Taylor** will replace Mr. Williams as branch manager in Los Angeles.

♦

Serving as sales representative in Cleveland and Pittsburgh for over twenty years and as western sales manager for year and a half, **J. L. McDermott** is now manager of the Ryertex division of Joseph T. Ryerson Inc. This division specializes in the sales of Ryertex nonmetallic bearings and bearing material and Glyco Babbitt metals.

♦

Vice president in charge of sales since January, 1943, **J. P. Dickinson** has been promoted to vice president and general manager of Stow Mfg. Co., Binghamton, N. Y. New vice president in charge of sales is **J. L. Dickinson. W. W. Rappman,** formerly assistant sales manager, has been made sales manager.

♦

The appointment of **John J. Eibye** to manager of magnetic component sales was recently announced by the Raytheon Mfg. Co., Waltham, Mass. Mr. Eibye will be responsible for the sale of voltage stabilizers, transformers and the Raytheon recitichargers and rectifilters.

♦

Sales representative in Allis-Chalmers' Detroit district office since 1945, **William W. Moore** has been named manager of the company's newly converted Toledo district office.

♦

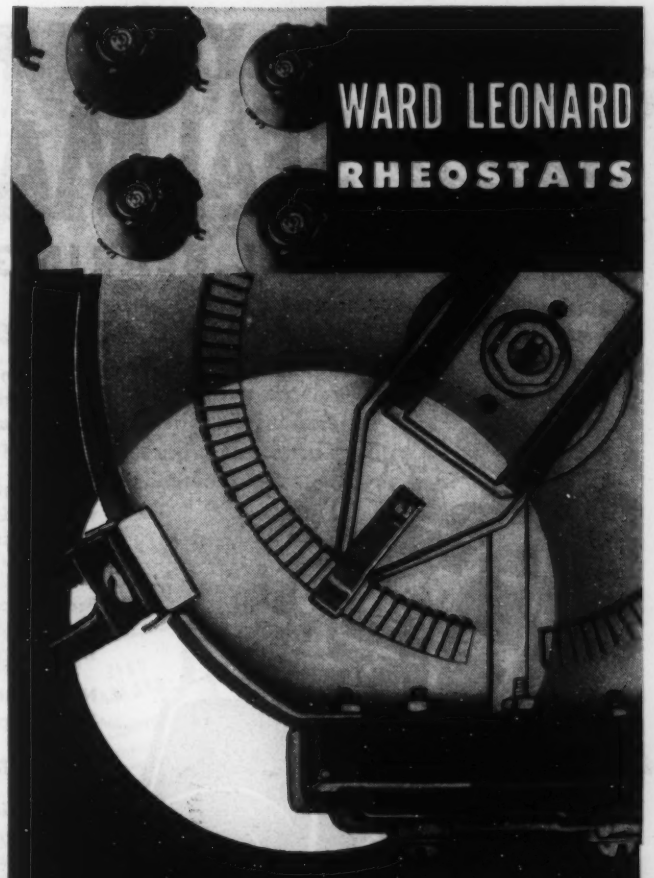
Formerly vice president of Storms Drop Forging Co., **Robert J. McKenna** is now the New England representative of the Billings and Spencer Co., manufacturers of precision and commercial drop forgings. Mr. McKenna's headquarters will be at the company's main office in Hartford, Conn.

♦

With offices at 274 Franklin St., Boston 10, Mass., **Warren M. Pike** has been appointed New England representative of the Farrel-Birmingham Co. Inc. to handle the sale of gears and gear units manufactured at the company's Buffalo plant.

♦

Philip A. Wagner was recently appointed office manager of the Chicago branch of Ozalid, division of General Aniline and Film Corp. **Charles E. Critchfield,** former Chicago office manager, has taken over a sales territory in the Chicago area.



because of solid rectangular contacts

The greater number of solid rectangular contacts gives Ward Leonard multi-step rheostats finer control with smoother contact arm operation—and with all the advantages of the Vitrohm construction.

The solid metal contacts, connected to the resistance element by a patented Ward Leonard method and embedded in vitreous enamel—assures a mechanically and electrically perfect joint for long and constant service.

Write for Rheostat Catalog. Ward Leonard Electric Co., 58 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY
Result-Engineered Controls
RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES
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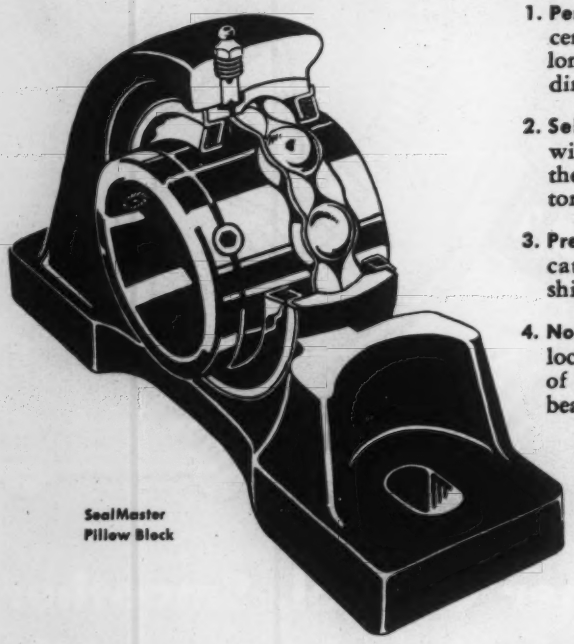
To Improve YOUR Product

Specify SEALMASTER

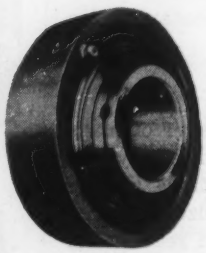
BALL BEARING UNITS

Because —

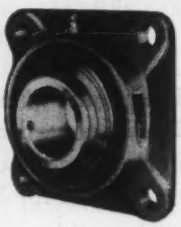


SealMaster Pillow Block

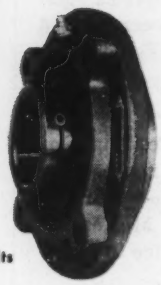
1. **Permanently Sealed**—Patented centrifugal flinger seal prolongs bearing life by excluding dirt and retaining lubrication.
2. **Self-Aligning**—Bearing unit, with seals, is independent of the housing. Seals are not distorted by shaft misalignment.
3. **Pre-Lubricated**—Factory-lubricated, all SealMasters are shipped ready for installation.
4. **No Housing Wear**—Patented locking pin prevents rotation of outer race and positions bearing for re-lubrication.
5. **Quiet Operation**—is assured by combination of deep-grooved lapped ball races and balls and felt-lined seals.



1. Cartridge Units



2. Flange Units



3. Flange Cartridge Units

It is the exclusive combination of design features that has made SEALMASTER ball bearing units essential on all kinds of industrial equipment. SealMasters are improving the performance of such products as air conditioning equipment, textile machinery, conveyors, road machinery, machine tools, oil field machinery, farming equipment and many others. Engineering data, dimensions and load ratings on the SEALMASTER line furnished on request.

Write us for YOUR free copy of SealMaster Catalog No. 845

BEARING DIVISION

STEPHEN S-A ADAMSON MFG. CO.

18 RIDGEWAY AVENUE, AURORA, ILLINOIS · LOS ANGELES, CALIF. ★ BELLEVILLE, ONT.

Factory Representatives and Dealers in All Principal Cities

Sales Notes

ESTABLISHMENT of a district sales office in Boston was recently announced by the **Babcock & Wilcox Tube Co.**, Beaver Falls, Pa. The new office, located at 250 Boylston St., Boston, Mass., will be under the supervision of J. W. Bramley and will serve customers in the New England area.

♦

Offices of the Cleveland branch of the **Federal Products Corp.** have been moved to 1511 Warrensville Center Road, Cleveland 21, O. Customers in this territory are served by John C. Kelsey, branch manager, and Charles Reisinger.

♦

Users of electronic, electrical and metallurgical products in southern California and Arizona now have available to them the services of **P. R. Mallory & Co. Inc.**, of Indianapolis. A branch office of this company has been opened at 1338 South Lorena St., Los Angeles, Calif., under the direction of J. E. Templeton.

♦

New sales representative for the **Raytheon Mfg. Co.** line of voltage stabilizers is **Art Cerf & Co.** Located at 744 Broad St., Newark 2, N. J., the company will serve the upper New York state area.

♦

The Aluminum division of **Harvey Machine Co. Inc.** has established several additional distributorships under factory trained sales engineers. The Pacific and Northwest area will be served by Donald Gjesdhal; the Chicago territory, by Calven S. McKee; central and southeast section, by Art G. Bower, who will headquarter in Dallas, Tex.; and the Middle Atlantic states, by Charles A. Euler Jr.

♦

The **Standard Transformer Co.**, Warren, O., has announced the appointment of **Rietze and Co.**, 139 South Fifth St., Louisville, Ky., as representative in the state of Kentucky. Mr. H. Edward Rietze Jr. heads this company and will handle the complete line of Standard transformers.

♦

Henger-Seltzer Co., 120 South Hewitt St., Los Angeles 12, Calif., has been appointed West Coast sales distributor for a number of products

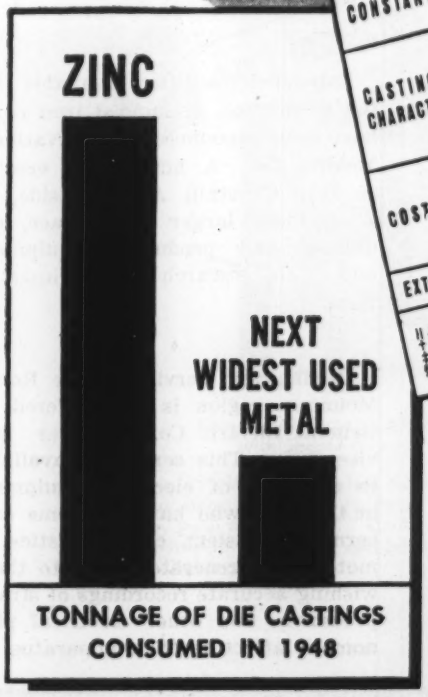
WHY ARE ZINC DIE CASTINGS THE MOST WIDELY USED?

The die casting process offers the least expensive method of making a very large variety of complex metal parts. Alloys based on several different metals are employed for die castings, but zinc has for many years been the most widely used. The answer is simple—the *zinc alloys provide the greatest number of desirable mechanical properties and casting characteristics at the lowest cost.* Future advertisements will discuss these advantages individually, to give you a better understanding of just what zinc die castings can do for you.

THE ANSWER IS HERE

SELECTION FACTORS		ZINC ALLOYS	ALUMINUM ALLOYS	MAGNESIUM ALLOYS
MECHANICAL PROPERTIES	Tensile Strength	1 (strongest)	2	3
	Impact Strength	1 (toughest)	2	2
	Elongation	1 (most ductile)	2	2
	Dimentional Stability	2	(1 most stable)	2
	Resistance to Cold Flow	2	1	1
	Brinell Hardness	1 (hardest)	2	2
PHYSICAL CONSTANTS	Electrical Conductivity	2	2	3
	Thermal Conductivity	2	2	3
	Melting Point‖	1 (lowest)	1 (highest)	2
	Weight, per cu. in.	3	1 (highest)	1 (lightest)
CASTING CHARACTERISTICS	Ease, Speed of Casting	1 (easiest)	2	2
	Maximum Feasible Size	1 (greatest)	2	3
	Complexity of Shape	1 (most complex)	2	3
	Dimensional Accuracy	1 (most accurate)	2	2
	Minimum Section Thickness	1 (thinnest)	2	2
	Surface Smoothness	1 (smoothest)	2	2
COST	Die Cost†	1 (lowest)	2	2
	Production Cost	1 (lowest)	2	2
	Machining Cost	1	2	1
	Finishing Cost‡	1 (lowest)	2	2
	Cost per Piece§	1 (lowest)	2	3
EXTENT OF USE		1 (most used)	2	

‖ A low melting point is favorable in reducing die cost and upkeep and facilitates casting.
† Dies for casting the low melting point alloys are least expensive and have longest life.
‡ Includes polishing and buffing expense as well as ease of applying all types of commercial finishes, both electrodeposited and organic.
§ Based on die and fuel costs, production speed and machining and finishing costs.



This comparison of the 1948 tonnage of zinc die castings and die castings of the next most widely used alloy are taken from a report prepared by the Bureau of the Census, Industry Division, Primary Nonferrous Metals Unit.

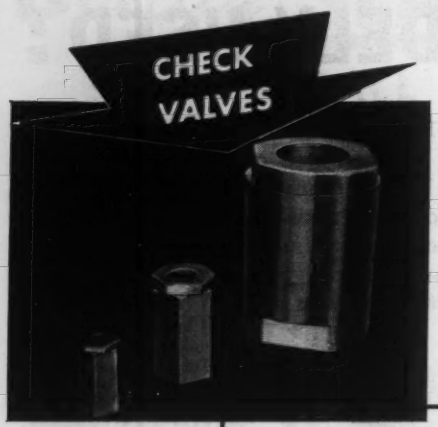
Ask your die casting source for our booklets covering all phases of the die casting process—properties, design, machining, finishing—or write directly to us.

ZINC
FOR DIE CASTING ALLOYS

THE NEW JERSEY ZINC COMPANY, 160 Front St., New York 7, N. Y.

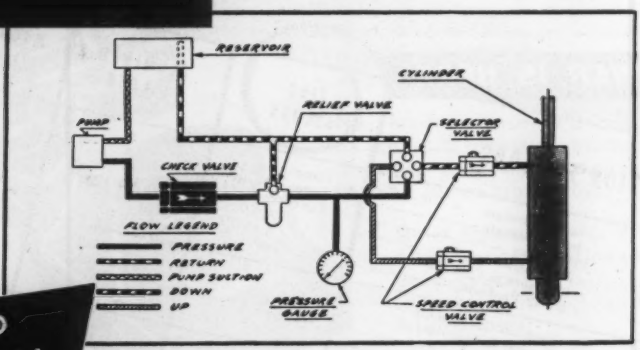
The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

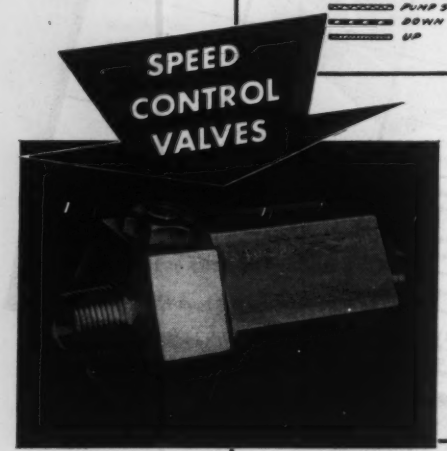
Meeting Your Hydraulic or Pneumatic Power and Speed Control Requirements



ELECTROL CHECK VALVES provide positive sealing from low to high pressures — 5,000 p.s.i. maximum. Standard models feature bronze and brass elements; special models, steel or other metals best suited to the service required. These valves provide air, gas, water and oil control lines with a minimum of pressure drop and positive sealing against return flow. They are successfully used in the hydraulic or pneumatic systems of busses, trucks, railroads, boats, aircraft, farm and road building equipment, and in a wide variety of industrial installations. Sizes range from ⅛" to 2" NPT.

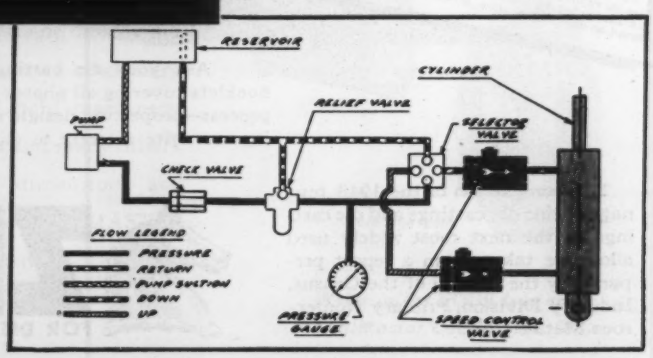
Illustration shows use of Electrol Check Valve in system to prevent loss of pressure through pump when unit is shut off.





ELECTROL SPEED CONTROL VALVES allow flow in one direction and—by use of a metering device—provide controlled flow in the opposite direction. Flow is controlled by a screw-actuated metering pin in the side of the valve. With pressures up to 1,500 p.s.i. and more, this valve handles air and oil—with equal facility—at high or low pressures. Standard sizes ⅛, ¼, ⅜ and ½ inch NPT ports. Special sizes to order.

Illustration shows use of Electrol Speed Control Valves in conjunction with actuating cylinder to control speed of piston rod motion in both directions.



Electrol engineers will gladly work with you in solving any problem involving hydraulics. Your inquiry will receive prompt attention.

Better Designed Products Use Electrol Hydraulics

Electrol

KINGSTON, NEW YORK

FOR BETTER HYDRAULIC DEVICES

made by **Fansteel Metallurgical Corp.** and its subsidiary, **Weiger Weed & Co.** Henger-Seltzer Co. has moved to new and larger quarters, and their stock will include electrodes, holders, tips, and dies for resistance welding; tungsten electrodes for inert gas and atomic hydrogen welding; tempered soldering tips, and hardfacing metal.

♦

New distributor of **General Electric** Textolite plastics surfacing materials is **Insulating Fabricators Inc.** of East Rutherford, N. J. H. D. Randall, an employee of General Electric for twenty-one years, will be in charge of sales of the plastics surfacing materials for Insulating Fabricators Inc.

♦

Sales offices have been established by the **Penn Metal Co. Inc.** at 8629 Thackeray St., Dallas, Texas. District sales representative A. A. Goodson Jr. will serve the territory of Texas, Oklahoma and western Louisiana in supplying expanded metal to manufacturers.

♦

Announcement has been made of the removal of the offices of **Process Gear & Machine Co.** to 18421 James Couzens Highway, Detroit 21, Mich.

♦

Expanded facilities available for the production of molded iron cores have been announced by the **National Moldite Co.** A new plant, erected at 1410 Chestnut Ave., Hillside, N. J., includes larger floor space, additional new production equipment and special research and test installations.

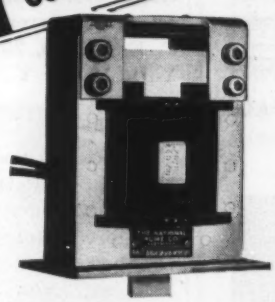
♦

Oscillograph service in the Rocky Mountain region is now offered by **General Electric Co.'s** Denver service shop. This service is available to all users of electrical equipment in the area who have problems concerning transient characteristics of motors and generators, and to those wishing accurate recordings of strain, pressures, and other electrical phenomena affecting their apparatus.

♦

Two new representatives of the **Hydro-Line Mfg. Co.** have recently been announced by the company. These are the **Hydraulic Service Co.**, 7550 Mayland St., Philadelphia, Pa., serving the Philadelphia area, and Mr. Alton J. Fabrey, 227 Fourth St., Scotia, N. Y., whose territory is western New York.

- ✓ Actuate Clutches
- ✓ Operate Switches
- ✓ Control Machines
- ✓ Print Identifying Symbols
- ✓ Operate Safety Devices
- ✓ Eject Work in Process
- ✓ Actuate Clamping
- ✓ Move Levers
- ✓ Operate Valves
- ✓ Vibrate Cutting Knives
- ✓ Open and Close Doors
- ✓ Hold Chucks
- ✓ Open and Close Hoppers
- ✓ Sort Inspected Parts



Namco Push-Type Solenoid with Saddle Stop

Namco "Stellite"—welded Solenoids are built in sizes with ratings from 2½ to 25 pounds, push or pull, at 1" stroke. Combination push-pull and other special applications are available.

If you have jobs like these... then you need SOLENOIDS

They're the modern, up-to-date way of doing jobs automatically—by remote control, and in cramped quarters if necessary.

With the positive, accurate action of Solenoids you can simplify design, manufacture and operation. They're taking the place of expensive, bulky gear trains, levers, linkages and other mechanisms. Many a manufacturer has come to us with a cost or space problem—and has found the solution in Namco Solenoids.

Namco Solenoids—with "Stellite"—welded contacts, are compact, rugged and reliable. They're *engineered* to the requirements of the job, with the aid of an *expert*. That's where we can help you. We'll be glad to recommend the size and style best suited to your job—with standard or special terminal blocks and mountings. Like more details? Ask for bulletin EM-46A.

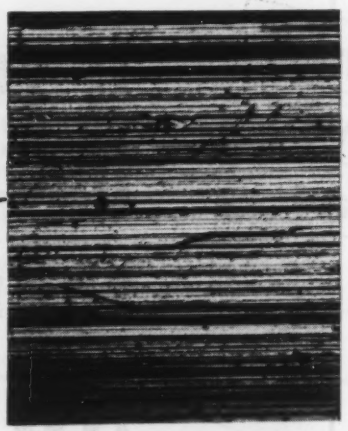
The NATIONAL ACME CO.

180 EAST 131st STREET • CLEVELAND 8, OHIO

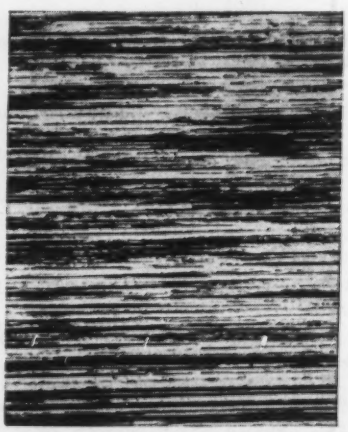
Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog • Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

YOU CAN SEE THE DIFFERENCE
IN HOOVER HONED RACEWAYS

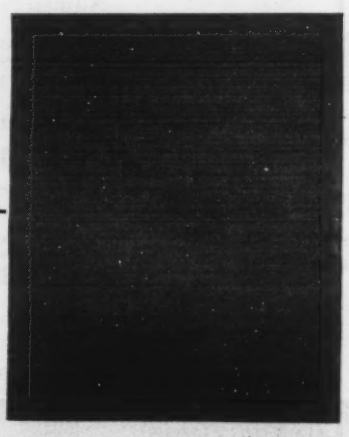
The photographs reproduced at the right are magnified one hundred times, so that you can see the difference between ground, polished and honed raceways. Hoover is America's only ball bearing with honed raceways. The process and the special machines for the honing operation, are exclusive, patented, Hoover developments. Hoover honing goes far beyond grinding and polishing to produce a surface that represents the closest approach to absolute perfection obtainable on a commercial basis.



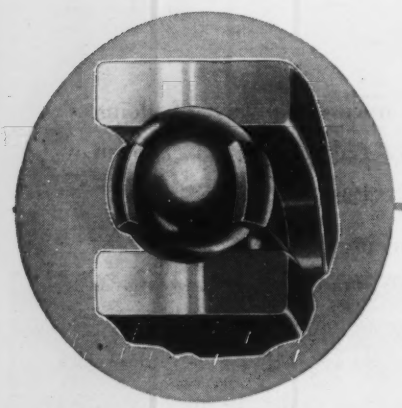
GROUND RACEWAY SURFACE
(Photographed at 100 Magnifications)



POLISHED RACEWAY SURFACE
(Photographed at 100 Magnifications)



HONED RACEWAY SURFACE
(Photographed at 100 Magnifications)



HONED RACEWAY FEATURES

Summed up Hoover honing provides the following results . . .

1. Extreme quietness.
2. Increased load capacity.
3. Extended life.
4. Reduced end play (axial displacement).
5. Reduced radial displacement.
6. Permanence of fit up.
7. Increased resistance to Brinneling.
8. Uniformity of fit up.
9. Freedom from vibration.
10. Perfection of dynamic balance.

A request on your Letterhead will bring a copy of the Hoover Engineering Manual

HOOVER
AMERICA'S ONLY BALL BEARING WITH HONED RACEWAYS

HOOVER BALL AND BEARING CO., ANN ARBOR, MICHIGAN

Meetings and Expositions

Sept. 13-15—

Society of Automotive Engineers. Tractor division meeting to be held at the Schroeder Hotel, Milwaukee, Wis. John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Sept. 15-16—

The Magnesium Association. Quarterly meeting to be held at the Hotel Statler, Detroit, Mich. T. W. Atkins, 30 Rockefeller Plaza, New York, N. Y., is executive vice president.

Sept. 26-28—

National Electronics Conference to be held at the Edgewater Beach Hotel, Chicago, Ill., under the sponsorship of the Illinois Institute of Technology, University of Illinois, Northwestern University, AIEE, and IRE. J. W. Armsey, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., is publicity chairman.

Sept. 28-30—

American Society of Mechanical Engineers. Fall meeting to be held at the Lawrence Hotel, Erie, Pa. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Oct. 2-5—

American Society of Mechanical Engineers. Petroleum Division Conference to be held at the Oklahoma Biltmore Hotel, Oklahoma City, Oklahoma. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Oct. 5-8—

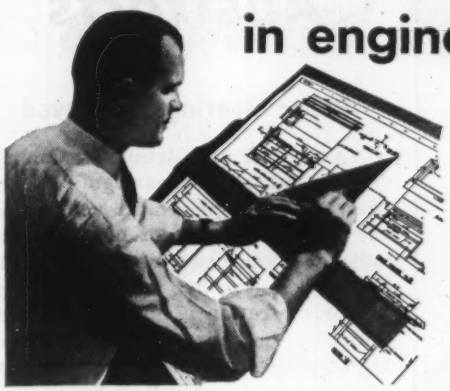
Society of Automotive Engineers. Aeronautic meeting and aircraft engineering display to be held at the Biltmore Hotel, Los Angeles, Calif., John A. C. Warner, 29 West 39th St., New York 18, N. Y., is secretary and general manager.

Oct. 10-14—

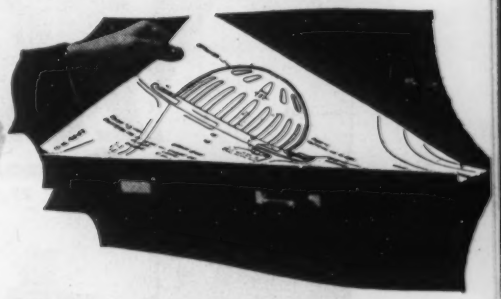
American Society for Testing Materials. First national meeting on the West Coast to be held at the Fairmont Hotel, San Francisco, Calif. Robert J. Painter, 1916 Race St., Philadelphia, Pa., is assistant to the secretary.

Here's low-cost protection

for the thousands of dollars you have invested in engineering drawings . . .

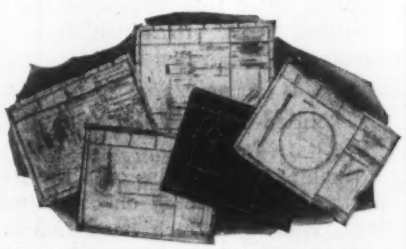


You can preserve every detail of your drawings by ordering Kodagraph Autopositive intermediates from your own reproduction department or local blueprinter. *Do this* . . . and you can keep your valuable originals in the files . . . protected against machine wear and tear, constant handling. *Do this* . . . and you'll have intermediates that set new standards for all-purpose use . . . that have dense, ink-like lines on a clear, durable, evenly translucent base. Intermediates . . . that will not smear or lose line density in handling or printmaking . . . that will produce sharp, clear blueprints and direct-process prints at uniform, practical speeds.



You get photo-lasting intermediates. Kodagraph Autopositives will not curl, turn yellow, or otherwise deteriorate in the files. Important protection, you'll agree, because you know from experience that intermediates are often the only masters available for printmaking in branch offices and subcontracting plants . . . and frequently in home offices. For this reason, more and more drafting rooms are standardizing on low-cost "Autopositives" of their drawings—old and new.

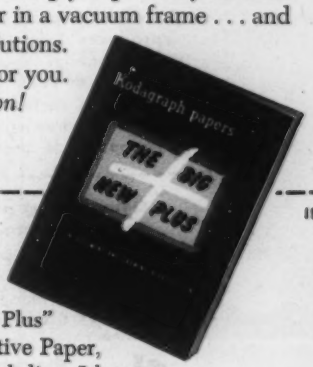
Kodagraph Autopositive Paper



You can reclaim unprintables —old, worn, soiled tracings . . . opaque originals . . . blueprints and direct-process prints, as well. From all of these you can get sharp, reproducible Kodagraph Autopositive intermediates . . . thereby eliminating costly delays and redrafting expense. And there's this advantage, too—you can make corrections and additions quickly, neatly . . . without weakening the high-quality, durable paper base.

Increased Protection at a new low cost . . . because Kodagraph Autopositive Paper is low in price, easy to process. Just think—positives are produced directly . . . without a negative step . . . without darkroom handling. Simply expose in your blueprint or direct-process machine . . . or in a vacuum frame . . . and develop in standard photographic solutions. Or have your local blueprinter do it for you. *It will pay to get the whole story—soon!*

Mail coupon for FREE booklet



19

Eastman Kodak Company
Industrial Photographic Division
Rochester 4, N. Y.

Please send me a copy of "The Big New Plus" —your booklet about Kodagraph Autopositive Paper, and the other papers in the new Kodagraph line. I have
☐ direct process ☐ blueprint ☐ contact printer equipment.

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EASTMAN KODAK COMPANY
Industrial Photographic Division
Rochester 4, N. Y.

"Kodak" is a trade-mark

Kodak

For those who want better prints

faster

Model 21 Bruning Whiteprinter for moderate print production.

BRUNING BW WHITEPRINTERS

There is a Bruning Whiteprinter to meet the requirements of any drafting or engineering department . . . and every one of them is designed to make perfect prints of your tracings . . . fast. In seconds after you turn on a Bruning machine you are producing copies that are tops in legibility. There is no time lost waiting for prints to dry . . . BW prints are ready for instant use as fast as they come from the machine. There is no time spent making negatives . . . BW machines make clear, sharp positive prints (black on white) directly from any copy that is drawn, typed or printed on a translucent material.

If you need sharp duplicate prints . . . big or small . . . on paper, card, film, or cloth, it will pay you to investigate Bruning Whiteprinters . . . the last word in efficient and accurate duplication of engineering and/or office forms.

CHECK THESE BW ADVANTAGES

Built-in constant wattage transformer: Protects lamp against voltage fluctuations. Assures longer lamp life, uniform prints, less waste.

No vents or exhaust fans: The BW process is completely odorless . . . can be performed anywhere in the office without the slightest offense.

No plumbing connections: There are no pipes to connect, no water to supply or drain away. Nothing to anchor the machine to one spot.

Wide variety of prints: BW prints can be made on light, medium or card weight paper with black, blue, red or brown lines. Also on tinted stocks, transparent paper, film and cloth.

Countless uses: A BW Machine reproduces letters, invoices, charts, financial reports or other documents as easily and quickly as it makes perfect prints from engineering drawings. It is truly a company-wide machine.

Other Bruning products you should know about

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Let us send you a file of descriptive literature on Bruning Whiteprinters and BW materials. There is no obligation. It would be helpful to know approximately how many copies you plan to make a day and their average size.

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Design Abstracts

Roller Bearings Improved

CAREFUL and detailed examination of roller bearings removed from turbine engines has revealed that the principal source of bearing difficulty lies not in the steel races, not in the steel rollers, but in the roller separator or retainer. The separator normally used in these high-speed, high-temperature bearings is made of free machining yellow brass. It is guided, or held in place, by sliding on shoulders of the bearing inner race. This portion of the bearing consists, therefore, of a sleeve bearing with a length extremely short compared to its diameter. Sliding action between the separator and its inner race guide, and between the separator and the rollers which it spaces and by which it is driven, requires excellent lubrication at these points. This is difficult to provide during starting and stopping when the sliding velocities are low. The very low viscosity oils used in aircraft gas turbines to obtain satisfactory low-temperature starting characteristics make it more difficult to build up a separating oil film between the parts of the bearings used in such engines and, in addition, impose the hazard that the bearing adjacent to the turbine wheel may become hot enough after the engine stops to volatilize most of the oil from its surfaces.

Rubbed-Off Brass Detrimental

Rubbing off of brass onto the steel parts has been noted on some bearings. Bearings which have failed in special engine tests show considerable smearing of brass upon the working parts, and usually broken retainers. It is thought that brass transferred to the steel parts by rubbing may under particularly adverse conditions weld to the brass retainer and result in a momentary halting of the retainer, skidding of the rolls, and breakage of the retainer.

In order to study full-size bearings under controlled conditions, a laboratory test stand has been constructed capable of simulating engine operating conditions of speed, load and temperature. With this laboratory machine, separator lubrication has been studied and the possibility of

(*Continued on Page* 195)

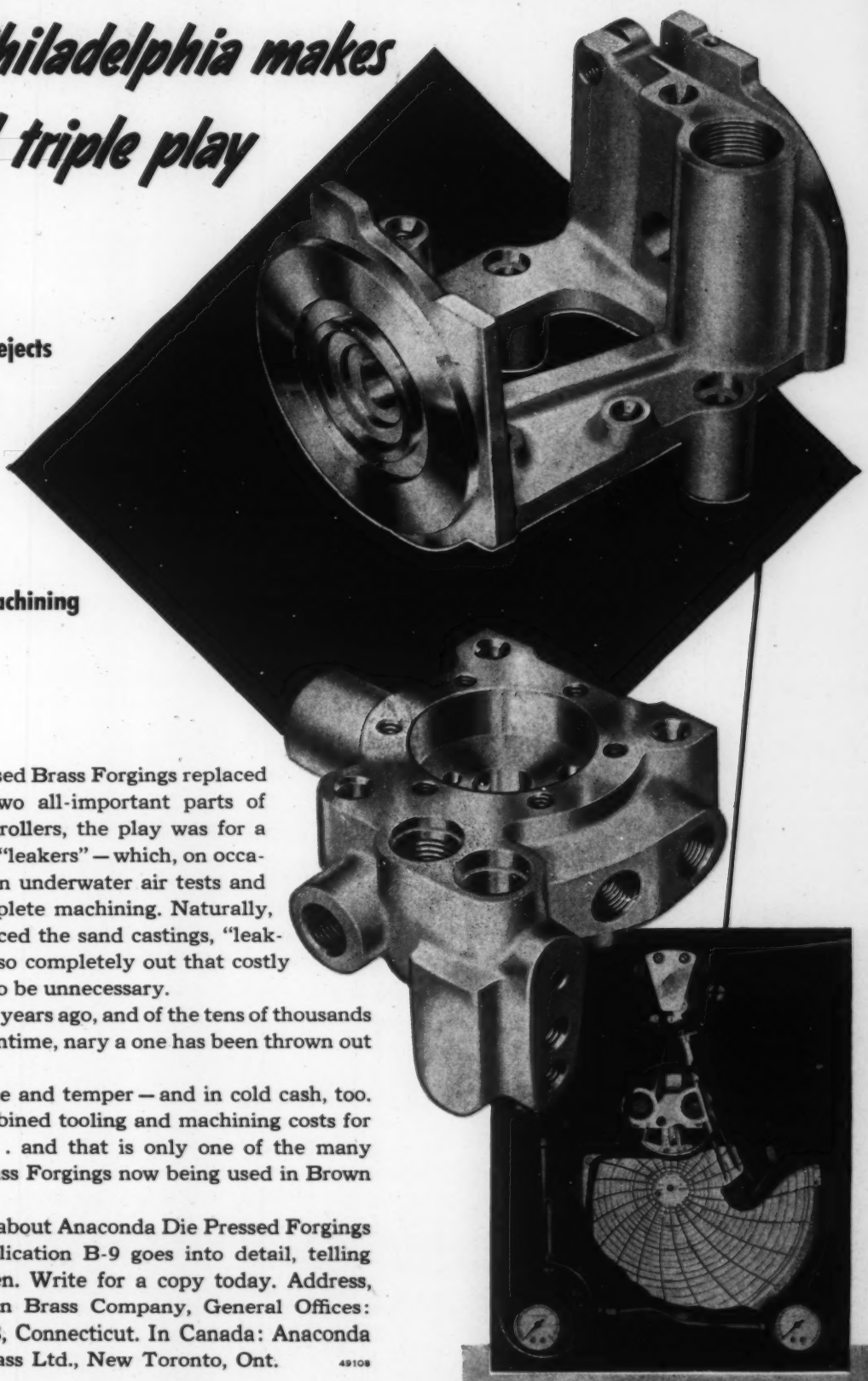
Wichita City Library

Brown of Philadelphia makes unexpected triple play

1 Abolishes costly rejects

2 Eliminates unit air testing

3 Saves 16% on machining



When Anaconda Die Pressed Brass Forgings replaced sand castings for these two all-important parts of Brown Air Operated Controllers, the play was for a single out — elimination of "leakers" — which, on occasion, ran as high as 60% on underwater air tests and showed up only after complete machining. Naturally, when *wrought* metal replaced the sand castings, "leakers" were out by a mile — so completely out that costly unit air testing was found to be unnecessary.

That was more than nine years ago, and of the tens of thousands of forgings used in the meantime, nary a one has been thrown out for porosity.

Savings? Plenty — in time and temper — and in cold cash, too. For instance: 16% on combined tooling and machining costs for the base forging alone . . . and that is only one of the many Anaconda Die Pressed Brass Forgings now being used in Brown Instruments.

There are a lot of things about Anaconda Die Pressed Forgings you'll want to know. Publication B-9 goes into detail, telling where, why, how and when. Write for a copy today. Address, The American Brass Company, General Offices: Waterbury 88, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont. 49108

ANACONDA

Anaconda DIE PRESSED FORGINGS

BROWN

This is the Brown AIR-O-LINE Recording Flow Controller, manufactured by the Minneapolis-Honeywell Regulator Co., Brown Instruments Division, Philadelphia. Brown Air Operated Instruments are used the world over for automatically controlling temperature, pressure, flow, liquid level and humidity in industrial processes.

Don't just pick any wire

Let us make it to fit the job exactly

Here in the mills of The American Brass Company, more than 100 different copper alloys are processed into wire in an almost unlimited variety of sizes and shapes, tempers and finishes. The result is that each wire is, in effect, tailor-made . . . especially adapted to particular problems of tooling, rate of production, and desired properties of the finished product. And there's a big difference — both in quality and unit cost — when the wire is exactly suited to the job!

The column at the right very likely holds the combination to that "one best wire". Our Technical Department will help you find it — and it may be easier than you think. Your inquiry entails no obligation whatever.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

ANACONDA
from m[illegible]sumer

Anaconda
COPPER and COPPER ALLOY
Wire

TYPICAL TYPES OF WIRE

Pin Wire	Hook & Eye Wire	Nail Wire
Screw Wire	Cotter Pin Wire	Rivet Wire
Chain Wire	Brake Lining Wire	Tie Wire
Slide Fastener Wire	Fourdrinier Wire	Welding Wire
Jewelry Wire	Trolley Wire	Brazing Wire

MATERIALS

Copper	Brass	*Hitenso Cadmium Bronze
Chromium Copper	Zinc	*Caison Bronze
Deoxidized Copper	Phosphor Bronze	Ambraloy
Silver Bearing Copper	Nickel Silver	Special Copper Alloys
Gilding	Cupro Nickel	*T.M. Reg. U.S. Pat. O
Commercial Bronze	*Everdur	

SIZES AND SHAPES .002" TO .750"

(Extreme limitations—varying according to alloy and shape)

Round	Half-oval	Square
Half-round	Flat	Hexagonal
Oval	Keystone	Octagonal
	Irregular Shapes on Order	

FINISHES AND TEMPERS

Cadmium Plated	Bare	Oxidized
Bright Annealed	Tinned	

From Soft Annealed through Spring Tempers; put up on Spools, Reels, Coils or cut to Straight Lengths.

SUITABLE FOR THESE FABRICATING OPERATIONS

Redrawing	Riveting	Braiding
Cold Heading	Machining	Spinning
Hot Heading	Flat rolling	Weaving
Extruding	Edgewise winding	

(*Continued from Page* 192)

improving performance by the use of other separator materials has been demonstrated. A number of general conclusions have been reached as a result of these studies:

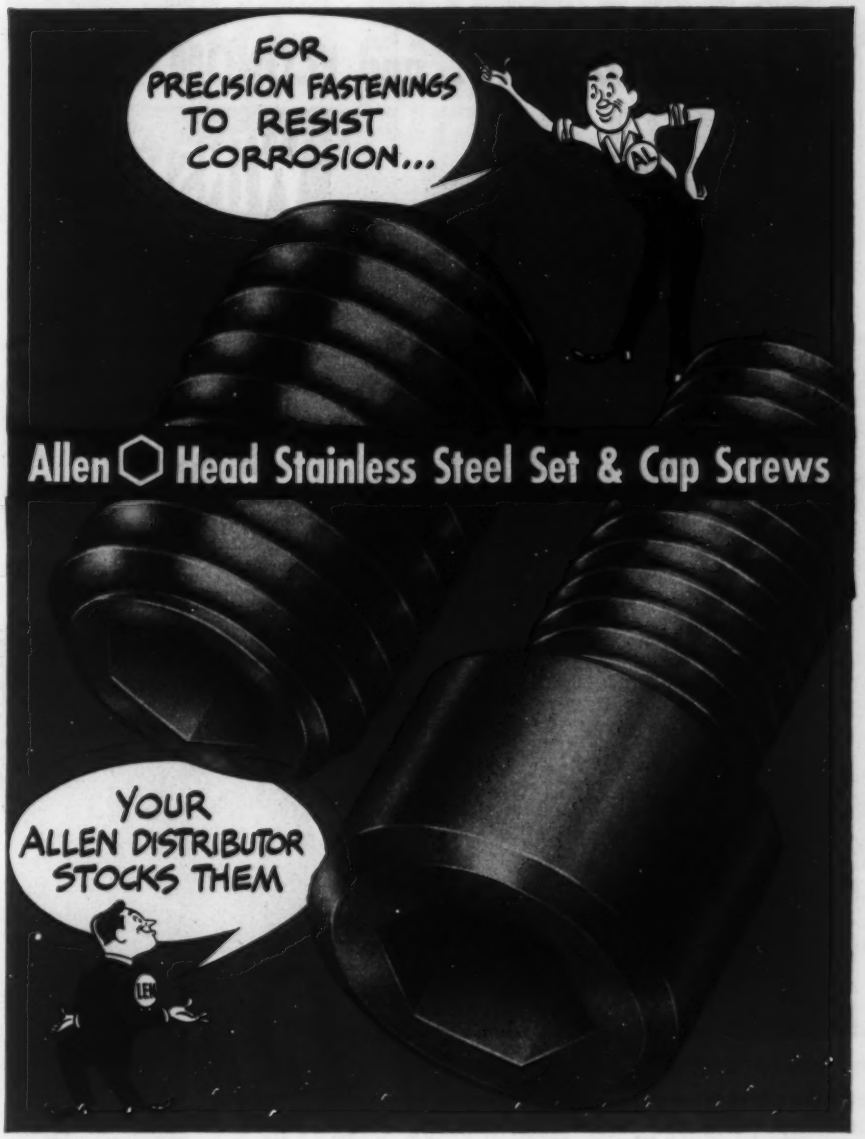
1. No difficulty is experienced in lubricating the roller bearings when they are running at high speed and are lubricated with a continuous jet of AN-0-9 Grade 1010 oil
2. Numerous starts and stops under lubricated conditions result in small amounts of brass being transferred to the steel parts upon which the separator slides. When the steel parts have been oxide coated to provide protection against corrosion, brass transfer is found to be more severe
3. Operation of the bearings dry results in rapid failure and destruction of the separator in a matter of minutes
4. Separator materials other than brass have been found which greatly improve separator operation under adverse conditions. Silver plating the brass separator prolongs bearing life operating dry several fold and greatly reduces metal transfer under poor lubrication conditions. It is the best of a number of electroplates tested
5. Other separator designs in which the separator is guided by the rolls rather than by the inner race may be better for operation under poor lubrication conditions, particularly when they include the use of better materials. These tests are still incomplete.

From a paper by Donald F. Wilcock and Frederick C. Jones, The General Electric Co., West Lynn, Mass., presented at the recent ASLE national meeting, New York.

Electric Braking of Motors

THE more common electric braking methods for induction motors are plugging, regenerative braking, capacitor braking, and d-c dynamic braking. Plugging is widely used as a means of braking because of the simplicity of the control and the large amount of braking torque that is obtained. In order to plug a three-phase motor all that is required is to reverse two of the three primary connections. Sometimes resistance is introduced in the primary circuit in order to limit the torque obtained.

In spite of its simplicity, plugging has several serious disadvantages. For example, if power is not removed from the motor when it reaches zero speed, the motor will accelerate up



When you need a combination of strength and resistance to most acids, alkalies or other corrosive substances, use stainless steel.

When you require stainless steel cap or set screws, your Allen Distributor has *the most complete line* . . . over seventy sizes that are standard.

You get the convenience of prompt delivery plus the regular Allen ⬡ Head advantages of strength, fine finish, strong sockets and the smooth threading made possible by Allen 100% Pressurforming. *Sold only through leading distributors.* Write for complete information on the Allen ⬡ Head stainless steel line.

QUICK FACTS ABOUT STANDARD ALLEN ⬡ HEAD STAINLESS SCREWS

Made of 18-8 non-magnetic stainless steel NC threaded. (No. 10 NF also standard.)

Set Screws in popular sizes from No. 6, 3/16" length to 1/2" x 3/4". Cup points.

Cap Screws in popular sizes from No. 8, 3/16" length under head, to 1/2" x 2" under head. Other threads, points and types of stainless steel available on special order.

ALLEN MANUFACTURING COMPANY
Hartford 2, Connecticut, U. S. A.
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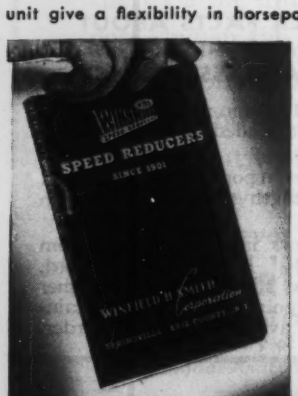
On the job at the recently redesigned James H. Gray Milling Co., Franklinville, N. Y. plant, above, is one of a battery of feed mixers employing Winsmith 40V vertical type reducers. Dairy and poultry feed, in batches of 2 tons each, are thoroughly mixed by this 40V assembly in less space than ever before. The 40V and 6 other sizes of the vertical unit give a flexibility in horsepower of from .19 to 81.51 . . . and reduction ratios from 5.1-1 to 50,000-1 and up. General dimensions are shown here from a typical Winsmith 148 catalog page.



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to synchronous speed in the opposite direction. Thus the operator must be depended upon to remove power at the right time or some automatic means must be used. In most cases the power must be removed automatically and this is accomplished under the control of a zero-speed switch. A second disadvantage is the large amount of losses in the motor while plugging. The losses while plugging to a stop are approximately three times as great as the losses while accelerating from zero to synchronous speed. In spite of these disadvantages, pluggiug is widely used and is quite satisfactory for a great many applications.

Braking Above Synchronous

Regenerative braking is obtained above synchronous speed and has the advantage of supplying high braking torque with relatively small loss in the motor. Power current is delivered to the line by the induction machine acting as an induction generator; however, excitation for the motor must be supplied by the line. A disadvantage of regenerative braking is the absence of braking torque below synchronous speed. Assuming the almost universal case of a constant-frequency power supply, regenerative braking is of no value for a single-speed induction motor except for limiting the speed of overhauling loads. Since overhauling loads are the exception on machine tools, regenerative braking is of value only in providing positive slowdown from high to low speed of multispeed motors.

Capacitor braking is a form of regenerative braking. If an induction motor is driven by some means and sufficient capacitance is connected across its terminals, it will function as a generator and supply power to a load. The capacitors must supply the reactive power required by the induction motor and the load. The frequency of the voltage generated will be roughly proportional to the speed of the motor, however, there must be some slip in order that the induction machine may supply power.

Capacitor braking is obtained by disconnecting the induction motor from the line and connecting capacitors across the motor terminals. Load resistors are sometimes connected across the motor terminals. Braking can be obtained by connecting capacitors across one, two or all three of the phases. More consistent results are obtained with the capacitors across two or three phases.

High torque can be obtained with capacitor braking and at the expense of relatively small motor heat-

ARC WELDING CUTS SHOP LOSSES ...lowers manufacturing costs

By A. G. Kullberg, Assistant Chief Engineer
Bay City Shovels, Inc.
Bay City, Michigan

By converting many of our power shovel parts over to welded construction, we have cut our manufacturing costs. Component parts that once required several weeks to complete are now being produced in as little as 10 days. Important also is the greater flexibility gained by reducing the number of patterns and the dependency on outside sources for cast materials, thus permitting product changes more quickly and at less expense.

Many of our power shovel parts are now fabricated from steel plate and from standard mill shapes. Formed parts are held in simple clamp fixtures and assembled by arc welding with Lincoln "Fleetweld 7" electrodes and Lincoln "Shield-Arc" DC welders or "Fleetwelder" AC arc welders. The AC arc welders are used on boxed-up members where arc blow otherwise limits the use of high welding currents.

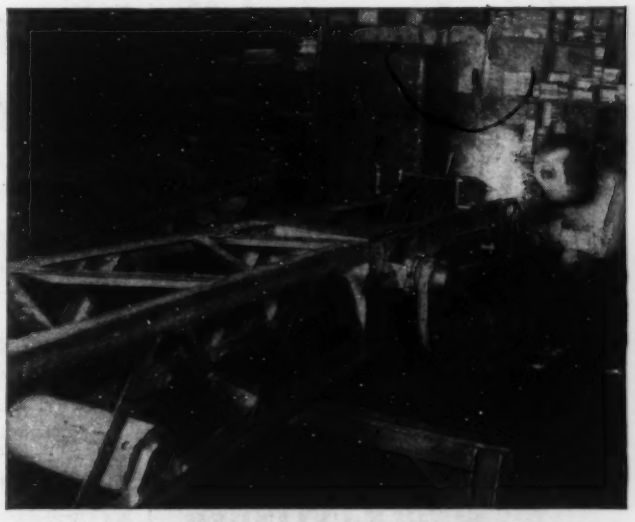
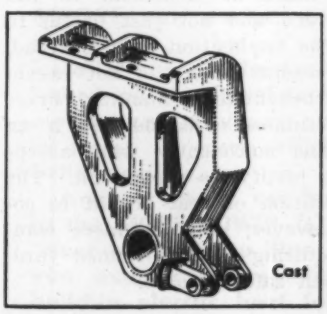


Fig. 1. *Rigid, strong and lightweight . . . This sheave-cage-to-boom assembly is typical of the high quality achieved at Bay City Shovels, Inc., Bay City, Michigan, with Lincoln "Fleetweld 7" electrodes and "Fleetwelder" AC machines.*

Our shop today is using arc welding to fabricate such shovel parts as buckets, booms, power transmission gear cases and motor mounts where strength is a prime requisite. We also build many of our smaller operating parts like handles, links and levers with arc welding—including sheet metal work up to 12 gauge for guards and cabs.



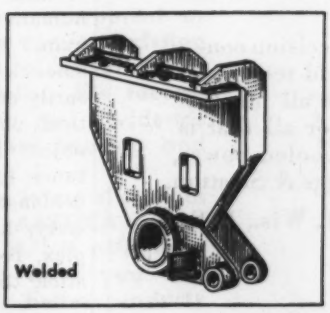
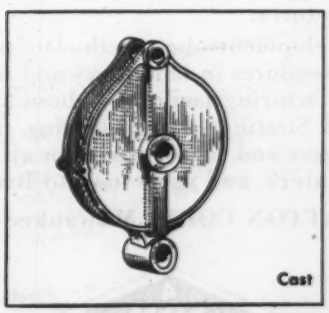


Fig. 2. Lowers cost 30% on Dipper Handle Yoke . . . *Eliminates need for more costly castings by fabricating part from lower cost steel plate and standard mill shapes.*



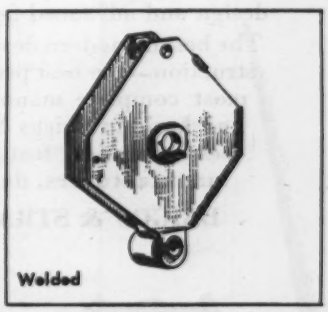


Fig. 3. Cuts material costs 54% on Dipper Sheave Cage . . . *Also eliminates excessive straightening and chipping formerly needed before machining. Total cost reduction on this part is 28%.*

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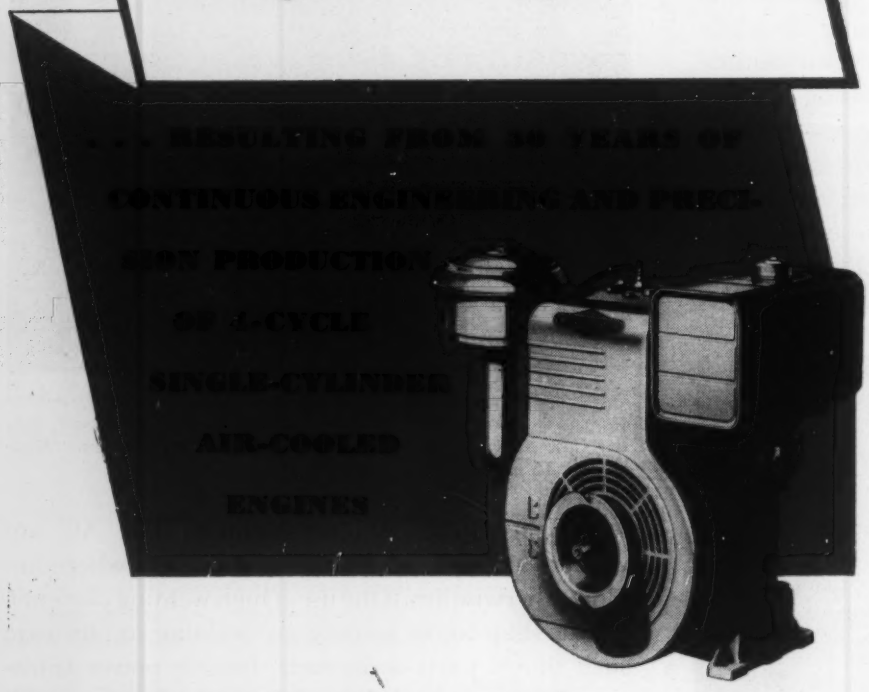

The experience gained in building more than 4 million air-cooled 4-cycle gasoline engines—during 30 years of uninterrupted production—plus the knowledge acquired in putting air-cooled power to work on all types of equipment, machinery and appliances—for civilian and military uses—in industry, construction, by railroads and on farms—all this broad technical background has kept Briggs & Stratton always *first* in modern design and advanced features.

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ing. The torque obtained with any one value of capacitance drops off very rapidly with speed since the generated voltage and frequency decrease with speed and the capacitance required to fully excite the motor therefore increases as the speed decreases. In most cases it is not practical to try to obtain braking torque below approximately one-third speed by this method.

D-c dynamic braking is another form of regenerative braking. It can be considered to be the operation of an induction motor with zero frequency applied to the terminals. High maximum torques can be obtained with d-c dynamic braking and at the expense of relatively little motor heating. The torque obtained falls off rapidly at high speeds for motors of normal slip making it necessary to use a high d-c exciting current if a fast stop is necessary. The scheme has the advantage of providing braking torque down to zero speed without danger of the motor reversing. Since d-c is generally not available, it is necessary to provide a source of d-c power such as a metallic rectifier and a time-delay relay to remove the d-c excitation after the motor has stopped. *From a paper by L. W. Herchenroeder, Westinghouse Electric Corp., presented at the Machine Tool Forum at Westinghouse Electric Corp. in Buffalo.*

The Engineer and Human Relations

A SIGNIFICANT definition of engineering, and in a sense the official definition of the profession, is as follows: "The art of organizing and directing men and of controlling forces and materials of nature for the benefit of the human race." This definition requires that the structures and machines which the engineer creates must be beneficial to the human race and not just useful to man. The implication here is broad, since a useful object is not necessarily of benefit to all mankind. Practical usefulness is established if an object has sufficiently wide acceptance to justify its production. The demonstration of real benefit to society, however, is much more complex, requiring a more refined yardstick than sales records.

Engineers Open to Criticism

In the larger sense of this broad definition, there is considerable dissatisfaction at the present time with the role of the engineer in society. This is voiced not only by sociologists and other students of human affairs,

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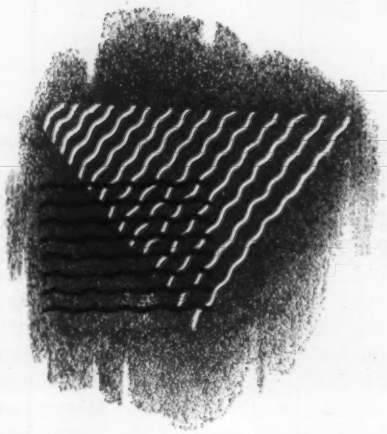

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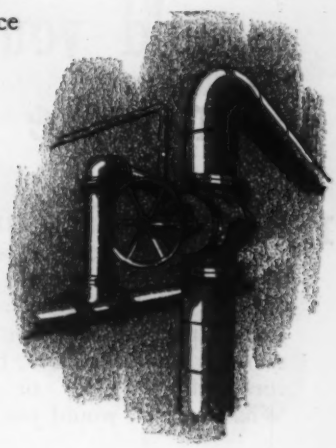

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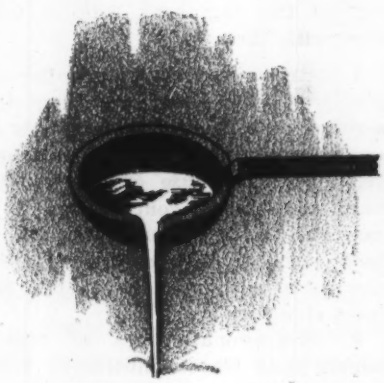

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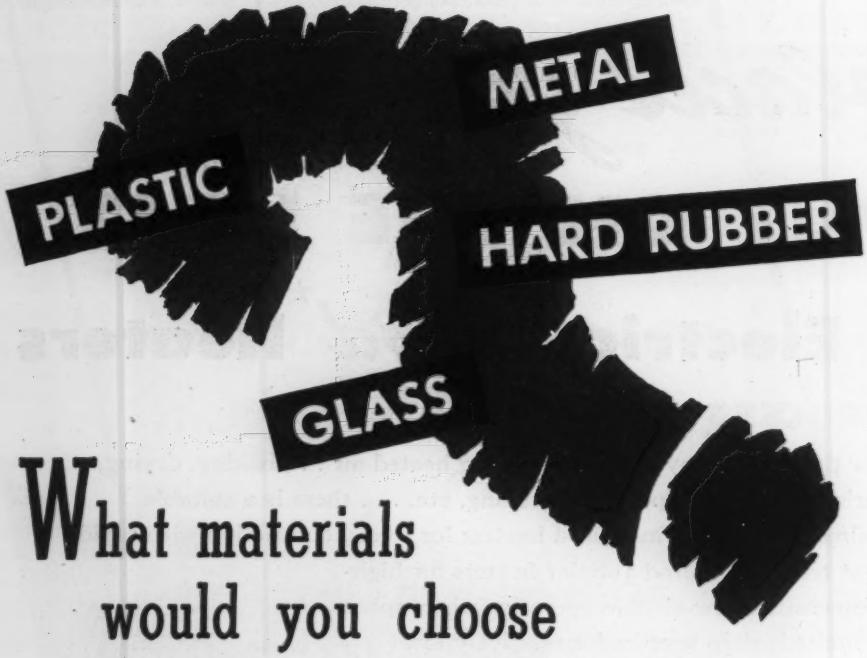
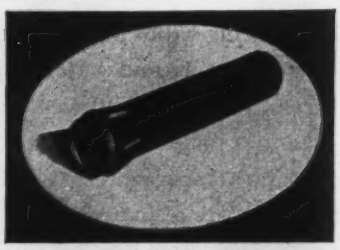
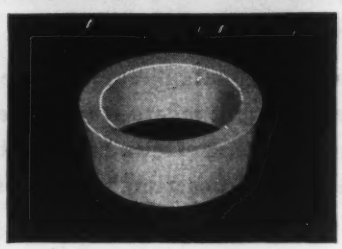


What materials would you choose for these parts?

1 INDUSTRIAL FLASHLIGHT CASE: Must be tough, good-grip, non-corrosive, oil-resistant surface. Should be electrically insulated. Plated, painted, imitation leather surfaces had been tried, but they corroded, chipped, or peeled. What material would *you* use?



2 Tapered gasket ring, exposed to acids, alkalies and essential oils, must impart no taste or odor to solutions. Must be free from "cold flow" for tight seal through a temperature range from 0° to 100° F. What material would *you* pick?



Answers: No. 1—Ace hard rubber, molded around brass tube, gives insulated, practically indestructible flashlight. No. 2—Ace Parian (polyethylene) is ideal for this gasket ring.

Yes, sometimes it's hard rubber, and sometimes it's one of the other plastics that's best. Ace, with many hard rubber and plastics compounds to choose from, is fully equipped to supply whatever you need. If you want this kind of impartial advice from your molder, select American Hard Rubber Company. Send for free 60-page Ace Handbook—a gold mine of helpful data.

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but also by leading engineers, as evidenced by the criticism which regularly appears in current engineering journals. In a word, the engineer is criticized for being too narrow in his interests, for limiting his responsibility to the functional design of machines and structures, and leaving to others all concern for their impact upon society. He has fulfilled his responsibility when a new machine, for example, turns out more units of production at less cost, without regard to the social and economic problems which may be created by such mechanization.

Technology's Beneficence

This attitude, the argument continues, springs from the widespread acceptance of the view that there is self-evident good in all technological advances which result in greater productive capacity. Secure in this belief, the engineer has not worried about temporary ill effects which are assumed to be more than offset by the total gain. At the Princeton Conference on Engineering and Human Affairs in 1946, R. K. Merton enlarged upon some of the undesirable consequences of technological advances and presented three reasons to explain the engineer's lack of concern with them:

1. Extreme specialization in the engineering profession, requiring the services of several different kinds of engineers to complete a particular development. Because of his well-defined and limited contribution, it is easy for the individual specialist, in such cases, to divorce himself from the social consequences of the finished structure.

2. Professional codes of ethics, which limit responsibilities to technical matters and discourage the engineer from venturing into "social" science.

3. The general employment of engineers in large organizations in which they take their place as experts in a subaltern role with fixed and limited responsibilities. In this status, they are rewarded for viewing themselves as technical auxiliaries.

From the physical scientist's point of view, John Mills has expressed somewhat the same idea in his book, "The Engineer in Society," published in 1946. Several quotations from the introduction of this excellent book are pertinent.

He writes: "The social effectiveness of the engineer is today almost entirely indirect. He develops, in general, what his employer wants, whether that employer is a govern-

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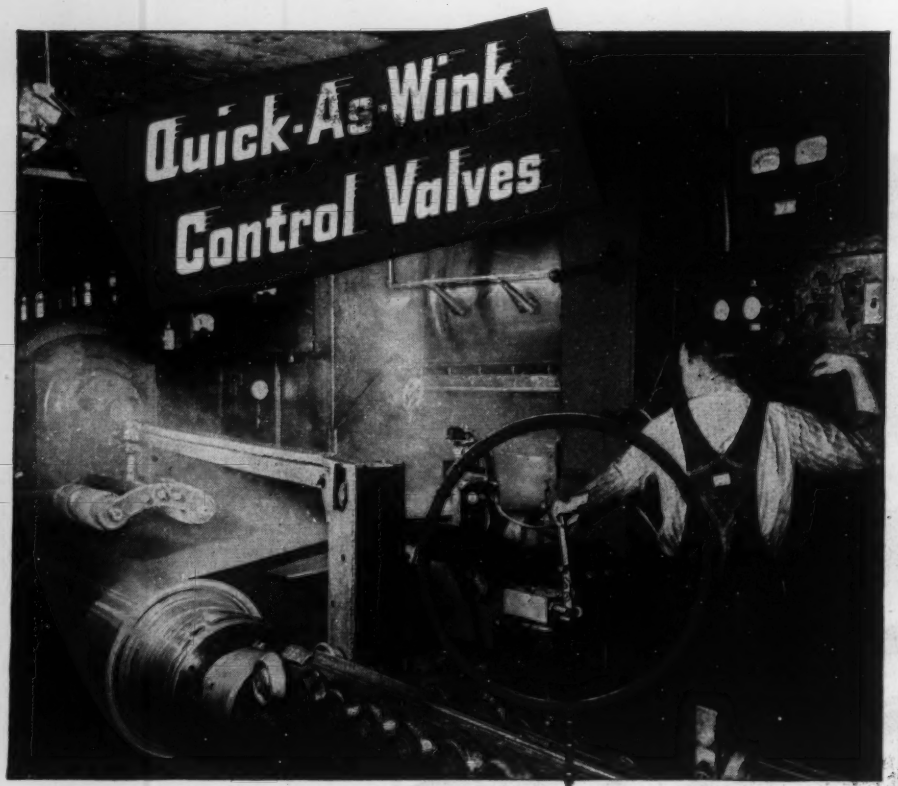

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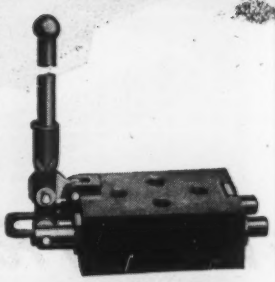

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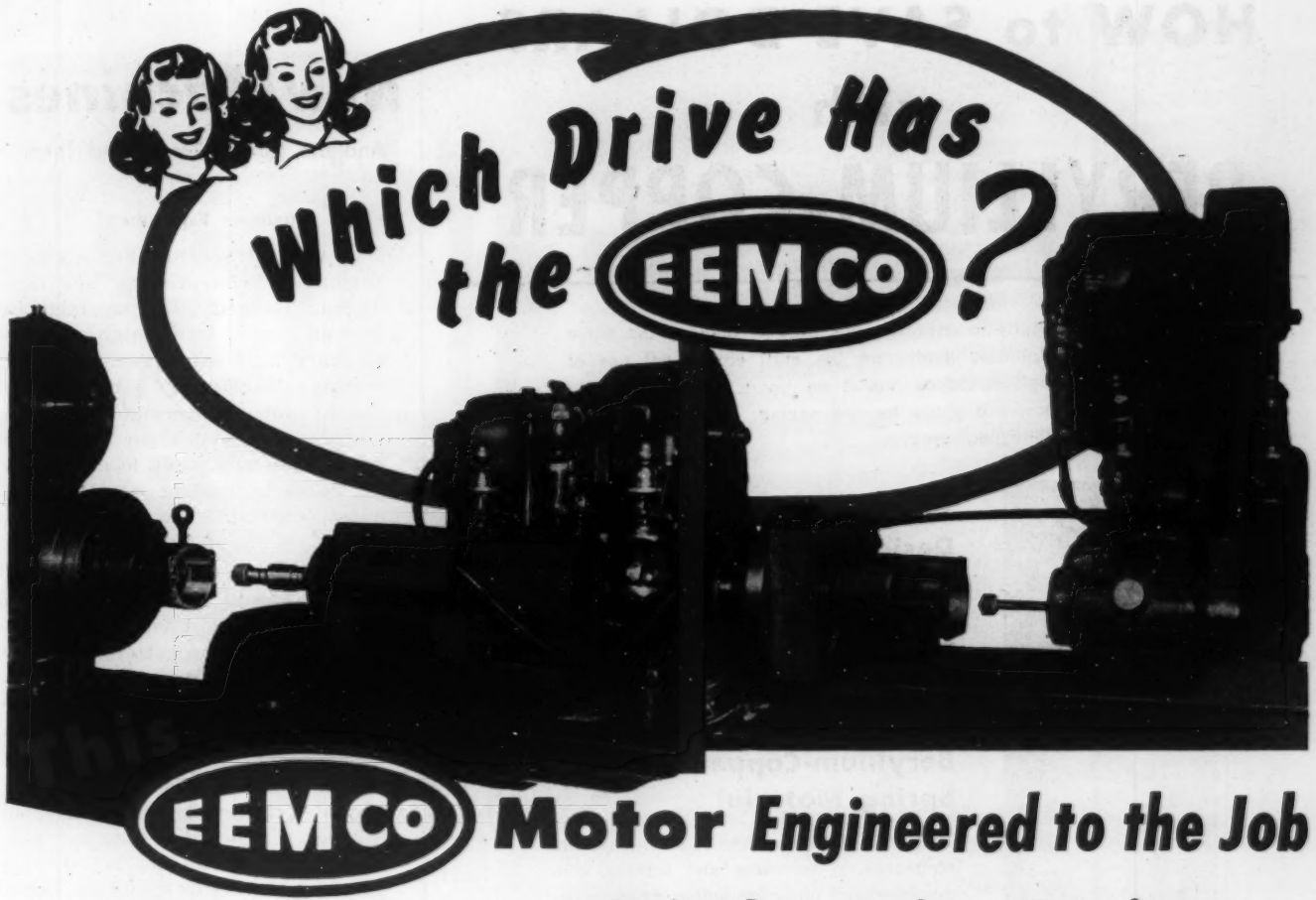
ment or a private corporation. He has little concern whether his products are utilized for general welfare or for violent destruction." And again: "The problems which he must help society to solve are those of human relations, social, economic, and political. These he must approach in the same way as he does those of engineering. That means he must apply to them the scientific method, discarding the prejudices of his early environment and avoiding the fallacies of his general education." Further: "If the engineer is to be effective in social contribution, beyond the physical instrumentalities he makes available, he must arrive at his conclusion in an engineering atmosphere, one in which the problem is objectively considered with like-minded colleagues."

These are broad points of criticism, wholly objective in nature, and, as such, they must receive earnest consideration and thought by engineers. In defense of the engineer, however, it can be said that he has done no more than share with American society as a whole his belief in the inherent goodness of technological advances. Indeed, no one suggests that we should stop or even slow down our technical progress; only that we give more attention than in the past to its total effect upon society. To quote from Merton again: "To the extent that social scientists have failed to address themselves to this problem, there is no informed basis for the most socially oriented of technologists to act with due social responsibility."

Scientific Approach Needed

Favorable, also, to the engineer is the need voiced by many social scientists for his point of view and systematic approach in the study of the problems of society. The engineer's insistence upon demonstrated quantitative relationships and specific laws, rather than upon broad general statements, as a basis for conclusions and action is required, it is claimed, to complement the skills of social scientists in the further advance of this field. These very attributes, however, lead the engineer to avoid such problems, because he is not convinced that they are capable of engineering analysis. When he does concern himself with social problems, he is apt to do so, not as an engineer, but as a general member of society. *From a paper by Theodore F. Hatch, research director, Industrial Hygiene Foundation, Mellon Institute, presented at Pittsburgh Section meeting of ASME.*



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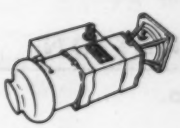

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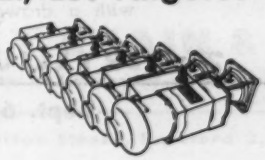

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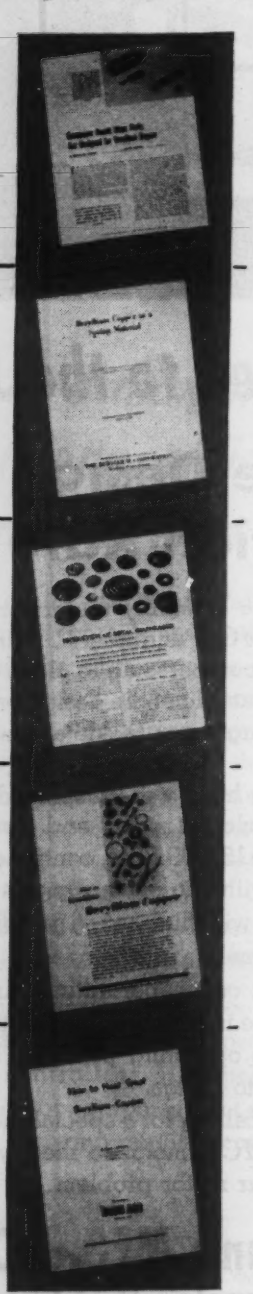

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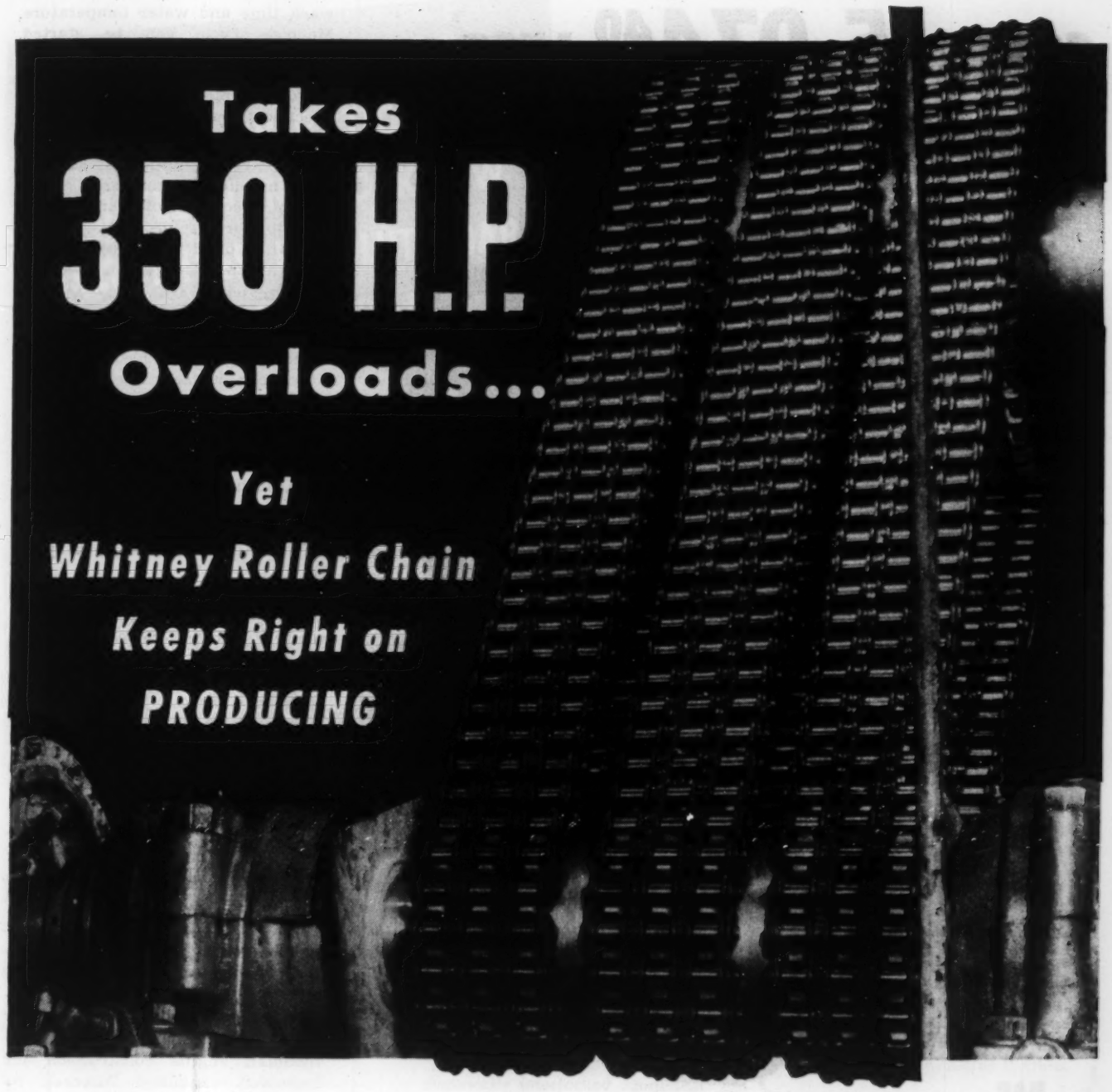
Commercial

AUTOMATIC WASHER. Coin-operated. Additional 5-minute soak period and increased water action complete wash process in 30 minutes. Pushbutton control of water temperature. Slug-rejecting coin mechanism has optional 10 to 50-cent operation. Motor increased to ⅓-hp. Dial window shows customer which stage of wash cycle is in operation. Light shows when machine is ready for use. Bendix washer distributed by Telecoin Corp., New York, N. Y.

DISPLAY CASES. Open-top, self-service models for groceries and markets. For meat, dairy products, and fresh vegetables. Provide 19¾-sq ft shelf area. Shelves adjustable to 10-degree angle. Meat and dairy cases use 3 dry expansion type gravity cooling units; vegetable case uses two units. Designed for operation with remote compressors. Finished in white porcelain and enamel. Frigidaire Div., GMC, Dayton, O.

Domestic

AUTOMATIC WASHER. Same as deluxe Laundromat except designed to be bolted down for permanent installation. Single dial control selects



Records prove the unusual ability of Whitney Roller Chains to withstand shock loads without breakage. A case in point is the following application:—

The head rig drive to the large nine foot Sumner Band Mill at Universal Box Company Ltd. incorporates 3 strand, 1½″ pitch, Triplex Whitney Roller Chains for positive transmission of power from the 300 HP synchronous motor. Despite surges in power up to 650 HP (or 350 HP overloads) during the cut run, Whitney Chains withstand these tremendous overloads and are performing day in and day out without failure. In addition to absorbing shock loads, Whitney Chains transmit full rated horsepower without slippage or friction loss. They deliver constant power smoothly and efficiently... stand up under the toughest of operating conditions. Write for information.

CHAIN DRIVE IS BETTER

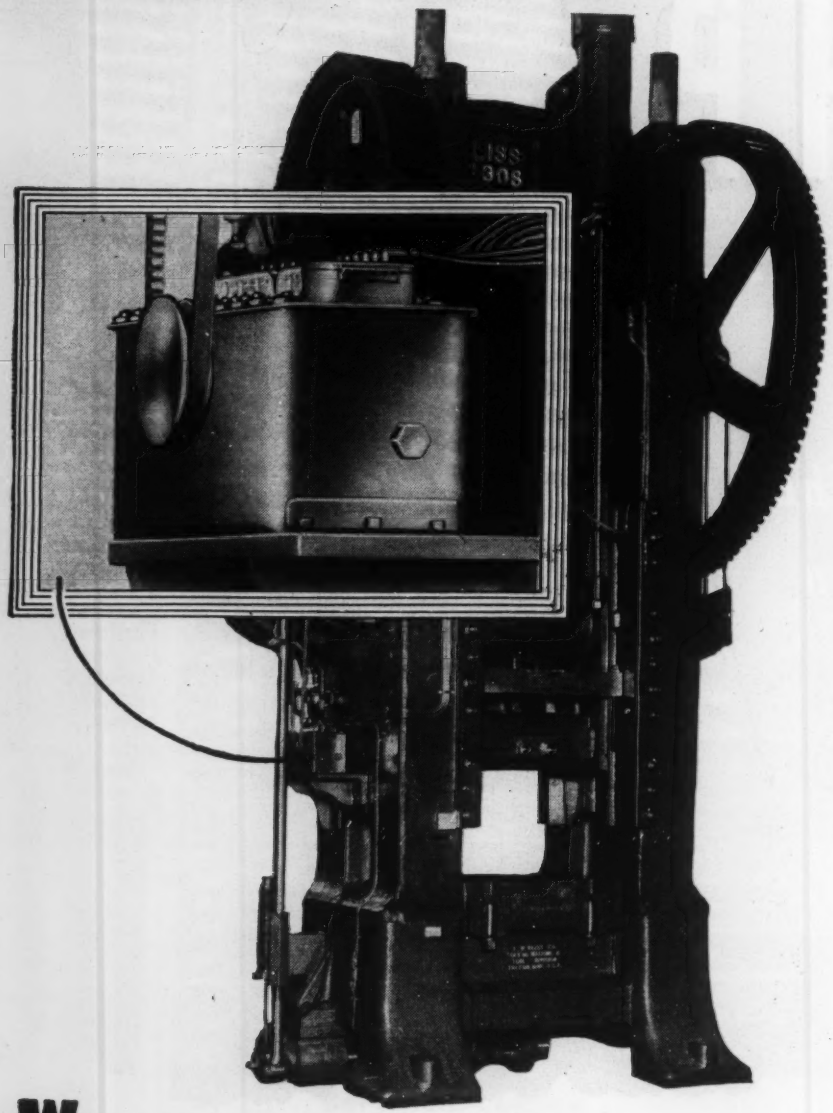
- Positive grip
- Transmits full horsepower
- Simplifies transmission designs
- Low maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds
- High resistance to shock loads
- High load carrying capacity

WHITNEY CHAIN & MFG. CO.

Division of Whitney-Hanson Industries Inc.

208 Hamilton Street, Hartford 2, Connecticut

COSTS $5,074.40 LESS THAN AN OIL CAN!



When the 20 hard-to-get-at bearings on this Bliss Crank Press were serviced by an oil can, it took 90 minutes a day at a labor cost of $2.10. In 10 years, with its modest initial cost taken out, this Manzel Model 25 Lubricator saves $5074.40 in labor alone. The oil saved by this non-wasting, never-forgetting guardian runs up to 60%...another *must* for Manzel Force-Feed Lubricators.

Manufacturers and users of pumps, engines and numerous types of heavy machinery have found Manzel Force-Feed Lubricators pay for themselves many times over. You probably have a lubrication job that can be handled much better and far more economically by Manzel equipment. Write us today for helpful information.

Manzel Inc. now supplies repair parts for all models of Bowser and Torrington Lubricators.

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Manzel INC.

A Subsidiary of Frontier Industries, Inc.

276 Babcock Street Buffalo 10, N. Y.

wash time and water temperature. Machine cycle can be started, stopped or repeated at any time. Sloping front insures ease of loading and unloading. Westinghouse Electric Corp., Pittsburgh, Pa.

WRINGER WASHER. With or without pump which empties 17-gal tub in 2 minutes. Drainboards tilt in either direction, rolls are adjustable to varying pressures. Capacity, 8 lb of dry clothes. General Electric Co., Bridgeport, Conn.

COFFEE BREWERS. Automatic. All-metal, double-bowl, vacuum type models available in aluminum alloy standard model and chromium-plated copper deluxe model. Capacity, 8 cups. Cup markings on inside and outside of lower bowl. Automatic thermostat mechanism controls water temperature, brewing time, infusion time and agitation, and keeps brewed coffee warm. Complete brewing cycle requires 10 minutes. Cory Corp., Chicago, Ill.

PORTABLE MIXER. Weighs 3½ lb without base. Placing motor in horizontal position reduces storage space required. Mixer speed selection through selector dial on front of motor. Blade cleaning simplified by elimination of center shaft between blades. Light illuminates bowl when mixer is in use. Power unit easily removable for use at range. Complete with juicer and bowls. Motor rated at 150 watts, 115-volt a-c or d-c. General Electric Co., Bridgeport, Conn.

Earthmoving

MOTOR GRADER. For low-cost maintenance and construction work. Machine weighs 8500 lb, features tandem rear-wheel drive, tubular frame construction and rear-mounted engine construction for improved visibility. Powered by 34.7-hp gas engine. Blade has hydraulic lift, side shift and 7 pitch positions. Grader has 4 working speeds forward, from 2.40 to 18.61 mph; reverse speed of 2.87 mph. Hydraulic controlled scarifier and loader; cab and snowplow available as accessory equipment. Allis-Chalmers Mfg. Co., Tractor Div., Milwaukee, Wis.

Heating and Ventilating

KITCHEN VENTILATOR. Used as window exhaust fan or can be snapped out of window panel and used as portable circulating fan. Mounts on inside of window frame, does not interfere with operation of window sash. Capacity, 550 cfm of air when used as exhaust fan; 900 cfm as circulating fan. Steel

IF YOU DESIGN FOR AIR OPERATION YOU'LL WANT TO KNOW ABOUT THESE REVOLUTIONARY AIR CYLINDERS

HERE are Air Cylinders so different in design that they have become known as the Bellows Air Motors. They are not rotary motors but double-acting, reciprocating, cylinder-type power units. Four-way directional valves and separate speed control valves for advance and retract strokes are built-in. Only one air connection is needed, which can be flexible hose.

Mechanically operated models are equipped with an operating lever which works from any angle in any plane. It may be operated by hand or foot, or may be linked mechanically with any moving element.

Electrically operated models are designed for electrically interlocked equipment.

Bellows Air Motors are available in bores of 1¼", 2½", 3⅜" and 4½", and in any stroke length. They can be mounted in any position.

WRITE FOR FREE BOOKLET

Complete description of Bellows Air Motors, technical data, dimensional tables, case histories, etc. Ask for bulletin BM-20. Address: The Bellows Co., Dept. MD-949, 222 W. Market St., Akron 9, Ohio.

● HYDRAULIC CHECKING OF AIR POWER

The Bellows Hydro-Check removes the natural "bounce" and "springiness" from air — gives the smoothness of hydraulic operation to air-powered equipment — but keeps the speed, flexibility and economy of air-operation. The Hydro-Check is available for use with all Bellows "Controlled-Air-Power" Devices or may be installed to regulate and control the piston movement of standard Air Cylinders.

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cuts machine down time

Get the story of the new time and money saving General Electric exchange plan for Tri-Clad integral-hp motors! It's an extension of the highly successful G-E fractional-hp motor exchange plan and covers most popular types of Tri-Clad open dripproof motors—one to five hp. Bulletin GEA-5189 is for motor users; Bulletin GEA-5180 is for machinery manufacturers. Write on your letterhead FOR FREE COPY: *Apparatus Department, General Electric Company, Schenectady 5, N. Y.*

Look for this extra on the motors you buy; it means lower maintenance costs, less time lost for motor replacement.

GENERAL ELECTRIC

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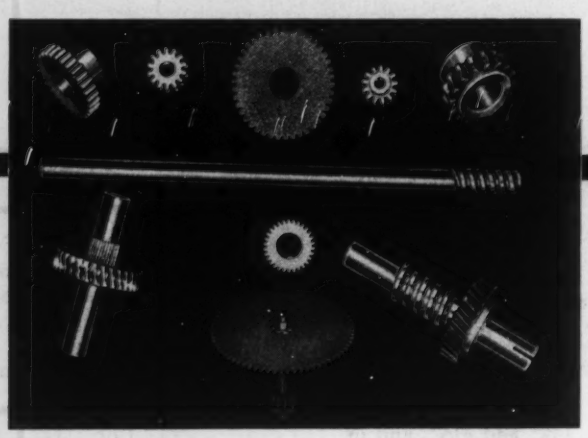

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window panel fits windows 24 to 36½-in. wide. Westinghouse Electric Corp., Pittsburgh, Pa.

INDUSTRIAL FAN. Capacity with 24-in. blades, 4240 cfm at 1140 rpm using 1/6-hp motor. Three aluminum blades mounted on steel hub, dynamically balanced to reduce vibration. Includes fan guard, 30-degree tilt, telescoping steel tubes in base adjustable from 5½ to 8 ft, or bench mounting. Baked black crackle enamel finish. Elliott Manufacturing Co., Binghamton, N. Y.

Heat Treating

ELECTRIC FURNACES. Bench type. Stepless temperature controller regulates current from 5 to 100 per cent time on and any temperature from 350 F to 1650 F continuous or 1900 F intermittent. Welded steel construction with 3-in. insulation. Two chamber sizes; 4-in. wide, 3½-in. high, and either 4½ or 9-in. deep. Thermo Electric Mfg. Co., Dubuque, Iowa.

Maintenance

PIPE THREADING MACHINE. Uses mechanically operated automatic chucks. Pipe placed in spindle is automatically chucked, centered and turned. Handles pipe from ½ to 4 in. Cutter wheel type machine allows fitting to be placed on pipe after threading without removing pipe. Oil pump driven from transmission. Thread length determined by light flashing every 2 revolutions. Four high-speed, quick-opening dies in each head, separate dies for each pipe size. Quijada Tool Co., Los Angeles, Calif.

THREADING MACHINE. Portable. For cutting, reaming and threading pipes to 2-in. diameter and threading solid rounds to 1½-in. diameter. Chucking and unchucking can be done as work rotates. Turning handwheel of wrenchless chuck centers other end and locks pipe or solid round in position for threading. Machine uses interchangeable monotype die heads. Peerless Machine Co., Racine, Wis.

VIBRATING CONCRETE FLOAT. For semi-finishing concrete and mastic floors, sidewalks, streets, driveways, etc. Floating of extra low moisture content concrete possible. Unit consists of 15-lb pulsating electromagnet vibrator mounted on 24 by 30-in. steel plate with 7½-ft tubular handle. Vibration can be varied to permit handling of concrete of various degrees of moisture and for finishing work. Syntron Co., Homer City, Pa.

MAINTENANCE TOWER. Hydraulically raised, manually operated. Work platform adjustable between 7 and

CROSS TRANSFER-MATIC

Another cost-cutting application of VICKERS HYDRAULICS

The Cross Transfer-matic illustrated here uses Vickers Hydraulic Controls in making substantial reductions in the cost of machining axle housings.

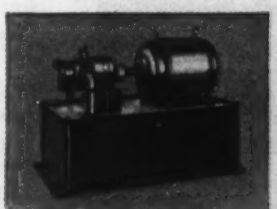
A hydraulic transfer mechanism automatically advances the housings (two at a time) from one machine to another. Hydraulic circuits of the individual machines provide for correct progressive positioning and clamping together with the traversing and feeding of the tool slides. Interlocks assure accurate positioning and secure clamping before cutting operations begin . . . also clearance of all tools before transfer to next station.

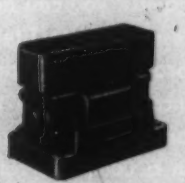
Exceptional flexibility is provided in that machines can be added, removed or shifted. Transfer mechanism is independent and moves work only from machine to machine. Locating and clamping are done by work holding fixtures integral with each machine.

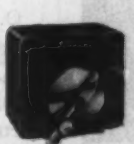
Indicative of the many advantages of Vickers Hydraulics are gasket mounted Vickers Control Valves that simplify installation, save space and make adjustment easier. Vickers Power Units are compact "packages" that simplify hydraulic system design and reduce costs.

Vickers Hydraulics are particularly adapted to provide the complex motions and operations needed in highly automatic machines. Get in touch with the Vickers Application Engineering Office nearest you for information on how Vickers Hydraulics can improve your machinery.

Representative Vickers Hydraulic Pumps and Controls Used on Cross Transfer-matic


Power Unit, Bulletin 46-43a


4-Way Valve, Pilot Operated, Solenoid Controlled, Bulletin 48-27


Flow Control Valve, Bulletin 45-35

Sequence Valve

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17 ft permits reaching work 23 ft above floor. Fabricated from tubular steel, tower is rolled to location on rubber-tired casters equipped with safety brakes. Safway Steel Products Inc., Milwaukee, Wis.

Manufacturing

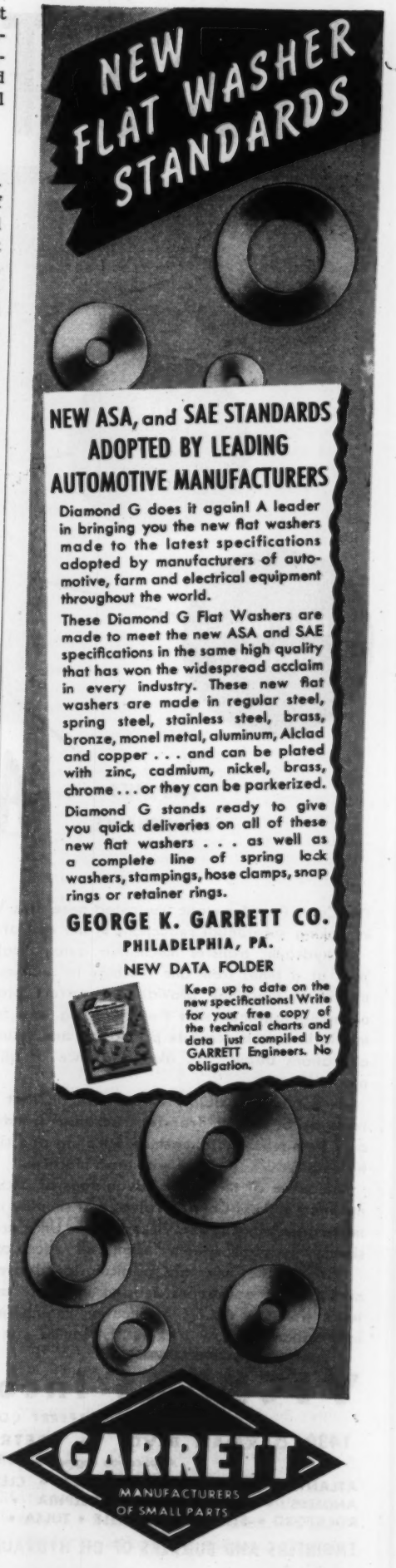
WESTIN PROCESS FORMING MACHINES. Requires 10 sec to close end of 4-in. diameter tube with ¼-in. wall thickness. Removable dies permit handling variety of applications. Successfully used with brass, aluminum, copper, carbon steels and most alloy steels. Transverse speeds infinitely variable from 0 to 100 in. per minute; spindle speed ranges from 40 to 150 rpm in 8 steps. Sizes available; ¾ to 4-in. diameters, 4 to 8-in. diameters, and 8 to 16-in. diameters. Federal Machine and Welder Co., Warren, O.

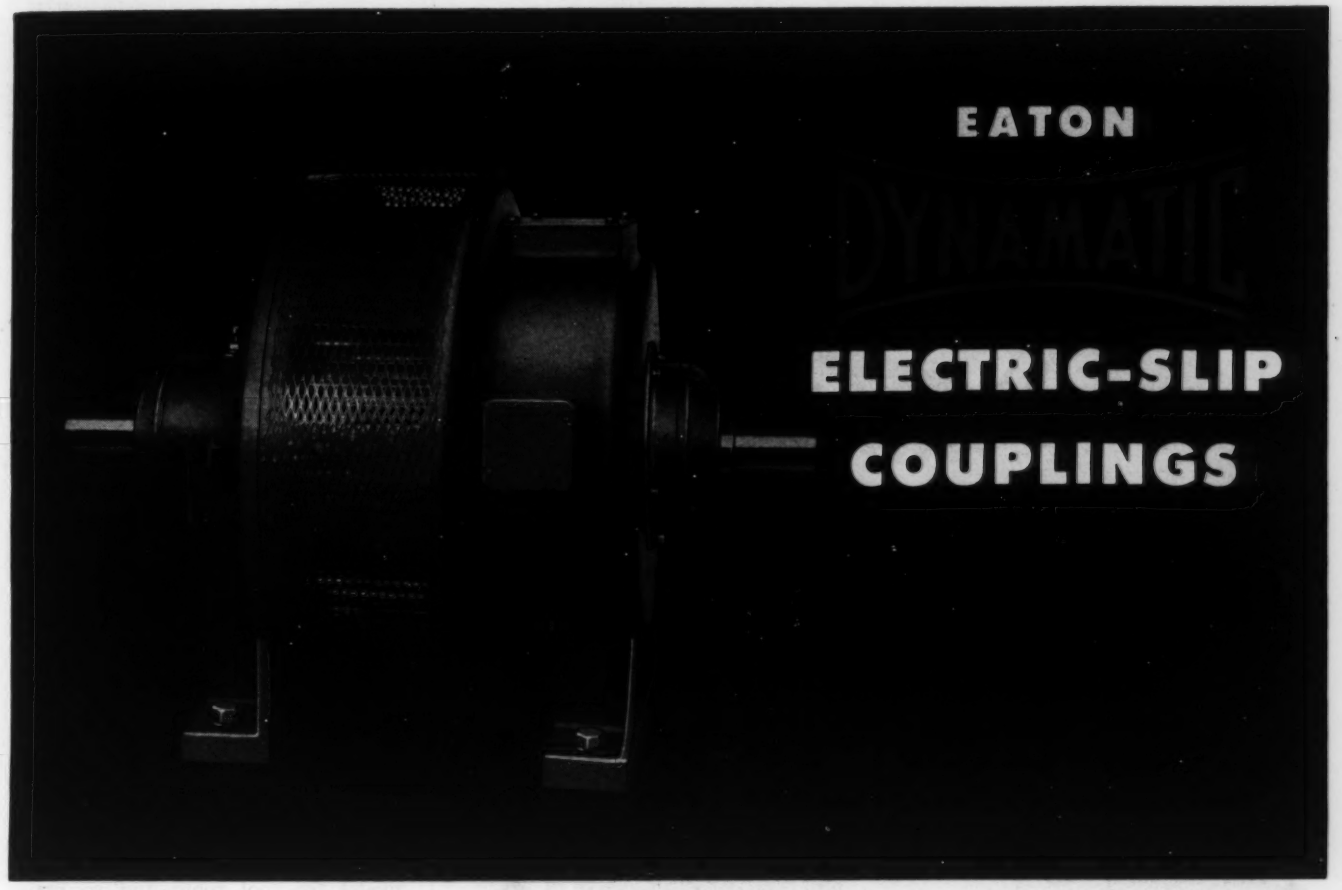
PUNCH PRESS. Capacity, 30 tons. For blanking, piercing, notching, bending, shearing and drawing. Features large bolster area 16 by 48 in., ram area 19 by 48½-in. Underneath double-crank mechanism results in compact design. Standard stroke, 2 in.; standard shut die height, 10 in.; ram adjustment, 2 in. Press operates at 80 strokes per minute. Diamond Machine Tool Co., Los Angeles, Calif.

PORTABLE SPOT WELDER. For maintenance work and general light welding. Weight, 23 lbs. Plugs into 110 or 220-volt lines. Entirely self-contained. Cast aluminum housing, transformer wound with double spun-glass insulated magnet wire. Welds to ⅛-in. combined thickness of metal, including stainless and mild steels, and 2 pieces of 18-gage galvanized. Protruding copper arms available in 6, 12 and 18-in. lengths. Greyhound A.C. Arc Welder Corp., Brooklyn, N. Y.

TAPPING MACHINE. For tapping couplings or nuts. Standard sizes of 1 and 2 in., in 6 and 8 spindle models. Spindles independently operated by worm drive running in oil. Worm cam provides quick return of spindle to upper position. Hydraulic spindle check cushions downward travel of spindle preventing impact injury to taps. Scroll type, self-centering chucks automatically operated by movement of spindles. Hill Acme Co., Acme Machinery Div., Cleveland, O.

SEMIAUTOMATIC LATHE. Low-swing model for shaft cutting involving long shoulder lengths and for short-run jobs where quantities do not justify setup time on fully automatic machines. Multiple-slide, front-turning carriage operates on





Variable Speed from Constant Speed Source

Dynamatic Electric-Slip Couplings can be applied to any shaft, in any type of machine to transmit motion from one rotating member to another without mechanical contact, without friction, without shock, and under complete control. Used as variable speed drives, power couplings, or slipping clutches, Dynamatic units have a wide range of industrial applications.

Dynamatic electric-slip couplings are a simple, compact, frictionless means of providing variable speed from a constant speed source, or constant speed from a variable speed source, with smooth, full-torque starts and cushioned stops. Outstanding characteristics are infinitely variable control, instantaneous response, quiet operation, low maintenance, electronic control.

Dynamatic couplings are available in both air-cooled and water-cooled types. The air-cooled couplings are designed to be powered by electric motors or engines at relatively constant speed; the output speed can be readily controlled and regulated. Sizes range from 1/4 hp to thousands of hp. Typical applications: fan and blower drives, centrifugal pump drives, calenders, extruders, wire drawing machines, draw benches, and printing presses.

Dynamatic water-cooled variable speed couplings are particularly adapted to installations in dusty or corrosive atmospheres, or wherever explosion-proof protection is necessary. Silent operation is a desirable feature. Sizes range from 10 hp to 1500 hp. Write for illustrated literature.

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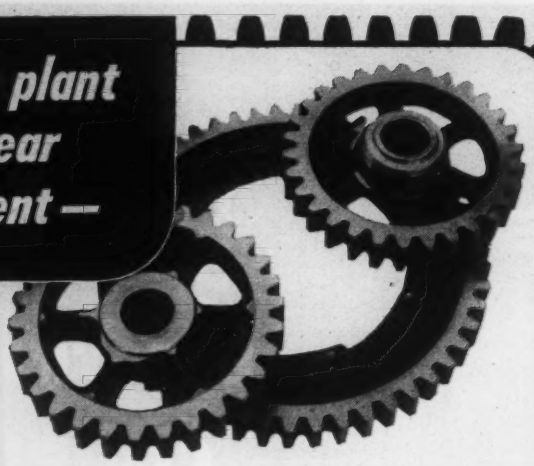

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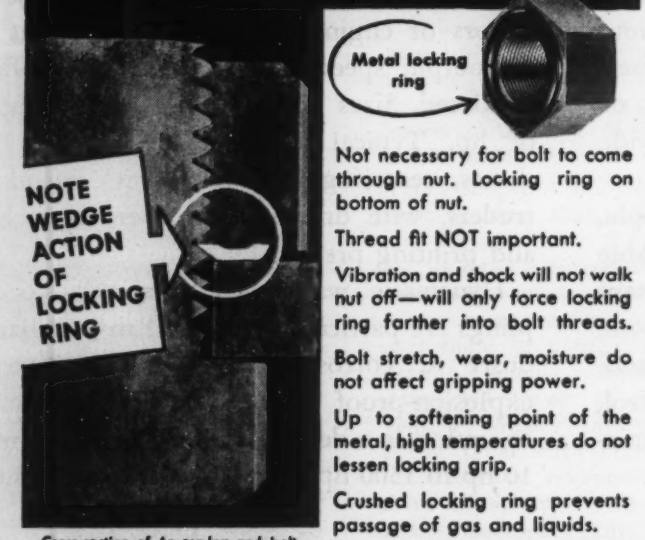

Cross-section of An-cor-lox and bolt showing locking ring after flattening.

Not necessary for bolt to come through nut. Locking ring on bottom of nut.

Thread fit NOT important.

Vibration and shock will not walk nut off—will only force locking ring farther into bolt threads.

Bolt stretch, wear, moisture do not affect gripping power.

Up to softening point of the metal, high temperatures do not lessen locking grip.

Crushed locking ring prevents passage of gas and liquids.

Nut can be re-used many times.

Available in high, thin, cap or spanner designs.

SEND for TEST SAMPLES and CATALOG

An-cor-lox Lock Nuts
TRADE MARK REGISTERED
LAMINATED SHIM CO., Inc., An-cor-lox Division, 1209 Union St., Glenbrook, Conn.
AN-COR-LOX NUTS • SHIMS • SHIM STOCK • STAMPINGS

rack and pinion principle permitting longer cuts. Hinged type steady rests prevent work from springing away from tool. Seneca Falls Machine Co., Seneca Falls, N. Y.

RESISTANCE WELDER. Multiple electrodes make 16 welds per muffler, 480 mufflers per hour, 4 welds at a time. Air-oil boosters operate electrodes through air valves actuated by sequencing mechanism. Powered by two 50-kva transformers. Taylor Winfield Corp., Warren, O.

TUBE SEALING MACHINE. For cathode ray tubes. Adapters permit handling 12 tubes to 16-in. diameter or 16 tubes to 12½-in. diameter per cycle of operation. Close tolerances of machine hold shrinkage to a minimum. Kahle Engineering Co., North Bergen, N. J.

HONING MACHINE. For small diameter parts, such as injector barrels. Size is held to 0.0001-in. on diameters; geometrical accuracy held to 0.000025-in. Surface finishes of 2 to 4 microinches rms are possible. Micromatic Hone Corp., Detroit, Mich.

HONING MACHINE. General purpose model for tool room and reconditioning work. With lateral indexing table, machine hones 6 six-cylinder automotive blocks per hour to less than 0.0005-in. tolerance on diameters. Hydraulically reciprocated head. Micromatic Hone Corp., Detroit, Mich.

UTILITY SHAPER. Precision 15-in. model equipped with universal table. Includes V-belt drive, one lever for all speed changes, micrometer dials for all feeding motions, 8 automatic power cross feeds in both directions, and opening in column throat for keyseating long shafts through column. Western Machine Tool Works, Holland, Mich.

DRILL. Upright model with capacity of 1-in. diameter in cast iron. Features 24-in. swing, infinitely variable spindle speeds with optional range of 190 to 2200 rpm backgeared or 400 to 2200 rpm regular. Includes 9 geared feeds, spindle-movement and feed-engagement control centralized in one handwheel, and automatic depth control dial for power feed. Powered by 1½-hp, 3-phase, 60-cycle, 1800-rpm motor. Requires 31½ by 48-in. floor space. Western Machine Tool Works, Holland, Mich.

Plant Equipment

ROTARY PUMPS. Sliding vane type. Handles viscous liquids up to 100,000 SSU. Vanes positively actuated

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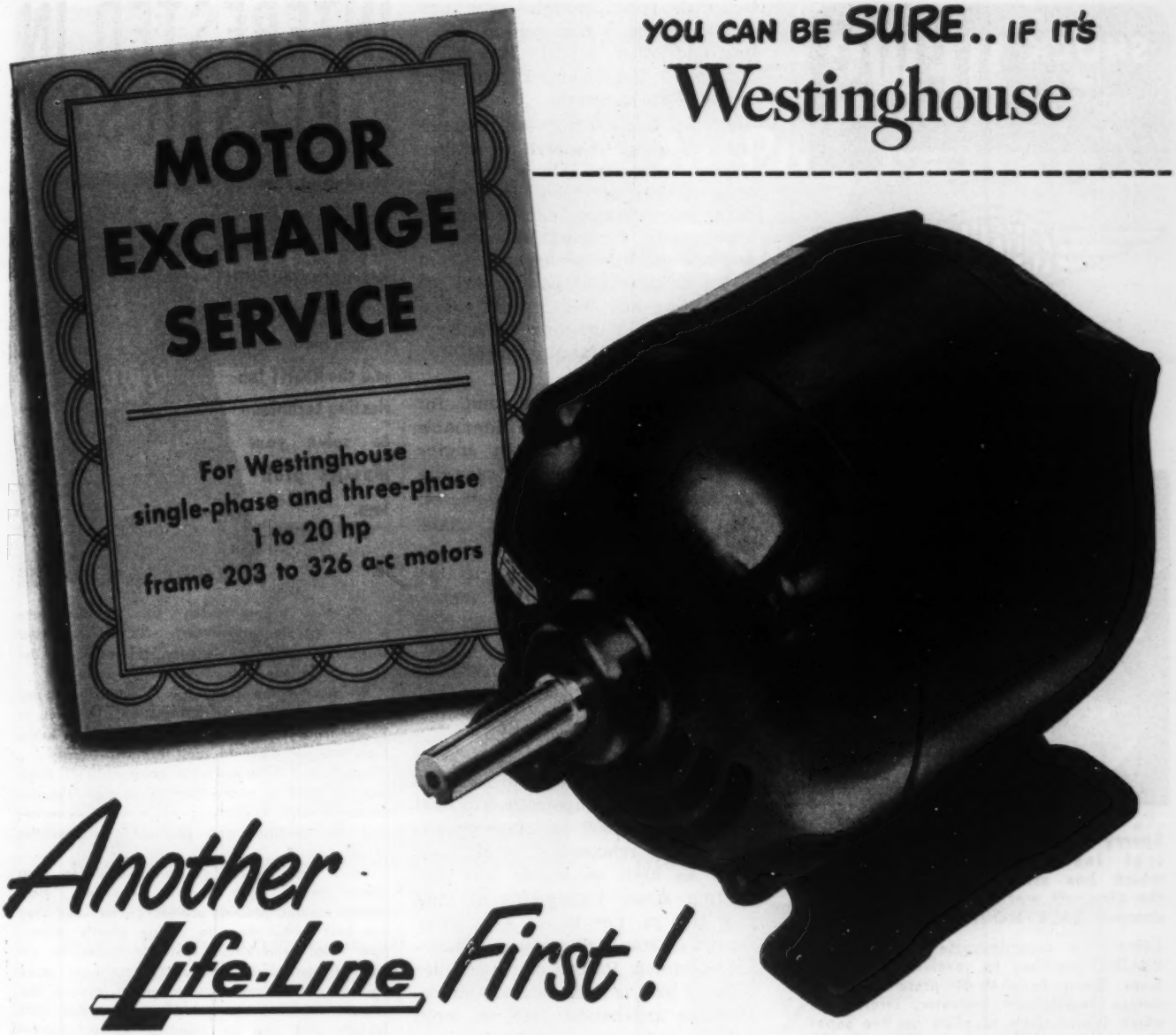
Westinghouse



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Since February, 1949, Life-Line motors have offered you the broadest exchange plan in industry. All 1 to 20-hp, single-phase and three-phase a-c motors in frame 203 to 326 are included. No other manufacturer of motors—large or small—provides exchange service that compares in scope to this new Life-Line Motor Exchange Service.

120 Westinghouse exchange points assure you rush motor replacement service anywhere in the United States. Replacement motors, covered by this plan, are in stock, ready to be speeded to you at any time.

And what's more, if a motor fails during warranty period, it may be exchanged *free* for a motor of identical rating. The *exchange price,* beyond warranty, *is not dependent on the time in service . . . one year, five years or ten years.*

This service is one more advantage you get with Life-Line motors. Add this to all-steel construction . . . pre-lubricated bearings . . . an indicated savings of $750 per year per 100 motors . . . and you'll see why Life-Line has gained leading acceptance in the motor industry.

Complete details on the Life-Line Exchange Service—lists of exchange points and motor ratings covered—are given in the new booklet SM-5243. Get your copy today from your nearby Westinghouse representative or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21533

Westinghouse *Life-Line* Motors

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BY BARRY

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. . . the new Sperry flight control instrument which has stirred the air-craft world is mounted on air-damped BARRYMOUNTS.

Literally a super-instrument, the ZERO READER promises to revolutionize instrument flying in that it presents, on a simple two-element indicator, information which is ordinarily supplied by five separate instruments, and directly tells the pilot how to move his controls. Its two coordinating cross-lines dictate the pre-set plan of flight to the pilot who merely acts as the "muscles" at the controls.

To protect this sensitive electronic "nerve center" from aircraft shock and vibration, Sperry Gyroscope Company mounts the ZERO READER on a base equipped with air-damped BARRYMOUNTS.

BARRY bases permit virtually instant installation and removal of the instruments they hold. Unit air-damped BARRYMOUNTS are also available for direct installation to airborne instruments.

Whatever your shock or vibration problem, Barry experience and consulting engineering facilities offer a sure solution. Write for our free catalog listing stock BARRYMOUNTS; for special information, call our nearest office or write to

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by push rods through rotor and shaft. Sliding action pumps gasoline and other volatile liquids efficiently. Blackmer Pump Co., Grand Rapids, Mich.

COMPUTING GASOLINE PUMP. Computer and meter mounted on sliding shelves in pump cabinet for easy removal and servicing. Air eliminator and pumping unit, motor and other units mounted on brackets and are quicky disconnected. Front and rear panels of cabinet lift off by turning key. Dial shows cumulative total of gallons sold. Dayton Pump & Manufacturing Co., Dayton, O.

PARTS WASHER. Portable unit for cleaning metal parts in flammable solvents. Reciprocating air engine moves perforated basket carrying parts up and down through solvent. Parts move through liquid, not with it. Hazard of spark igniting flammable vapors is not present as with electric motor. Cover is designed to automatically close and snuff out fire if contents should ignite. Protectoseal Co., Chicago, Ill.

Inspection and Testing

RELAXATION MACHINE. To establish relative ability of material to withstand stress at temperatures to 1800 F. Capacity, 4000 lb. Machine automatically relaxes tensional loads from as high as 40,000 psi, permitting strain increments of only 2×10^{-6} in. per in. of 6-in. gage length in standard 0.356-in. diameter specimen. Record of rate of decline of load is automatically made. Furnace dimensions: 18½-in. long, 8¼-in. O.D. 2½-in. ID. Baldwin Locomotive Works, Philadelphia, Pa.

SPRING TESTER. For high production testing of small coil, flat, and special design springs or spring assemblies to 12 in. long and to 5 lb load. Especially useful for wire sizes from 0.005 to 0.030-in. diameter. Equipment sensitive to load changes of 50 milligram; has weighing accuracy of plus or minus 0.10 per cent. Pointer amplifies weighing beam motion 10 times and indicates whether spring is within design tolerance limits. Baldwin Locomotive Works, Philadelphia, Pa.

Woodworking

PORTABLE SAW. Eight-in. blade. Weight, 13½-lb. Tilt attachment permits adjustment from 45 to 90 degrees. Max depth of cut, 2⅞-in. Helical gear drive to blade. Fan draws air through motor and discharges on work line. Idle speed, 5500 rpm; load speed, 2800 rpm; size, 12 by 8⅛ by 10½-in. Porter-Cable Machine Co., Syracuse, N. Y.

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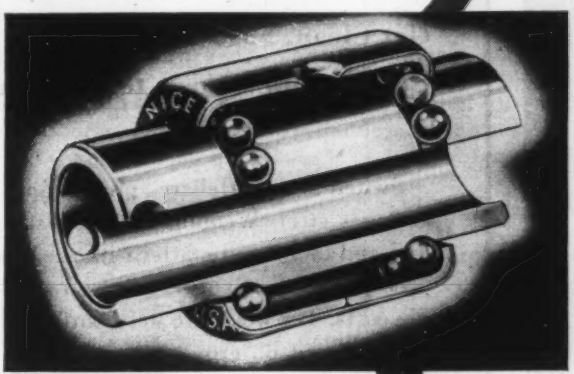

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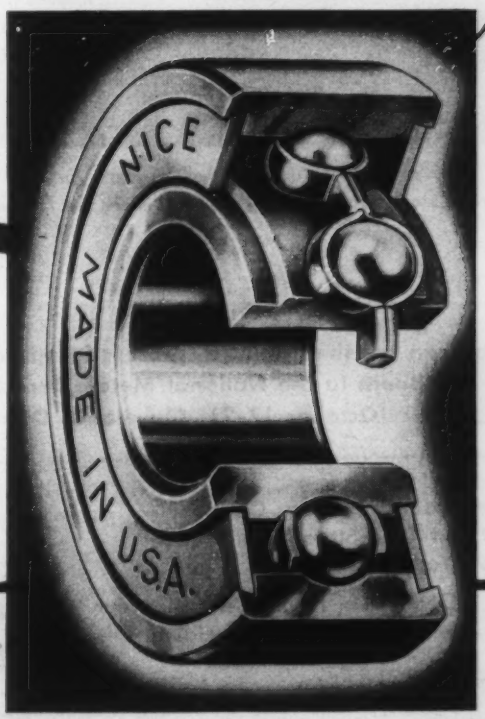

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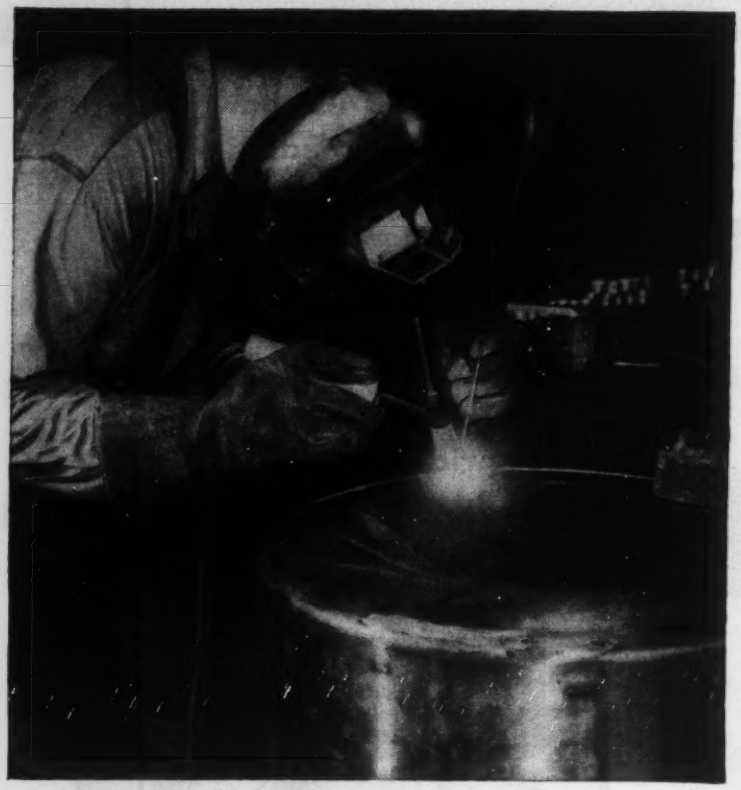

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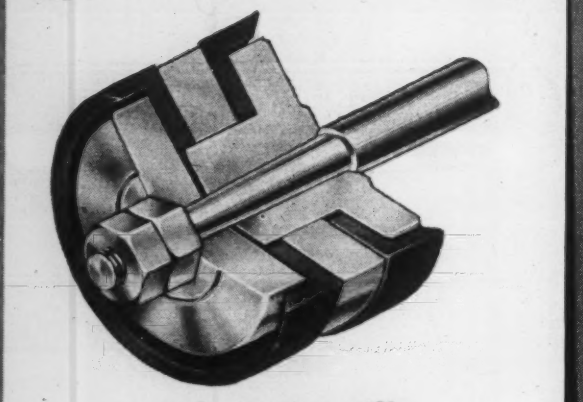
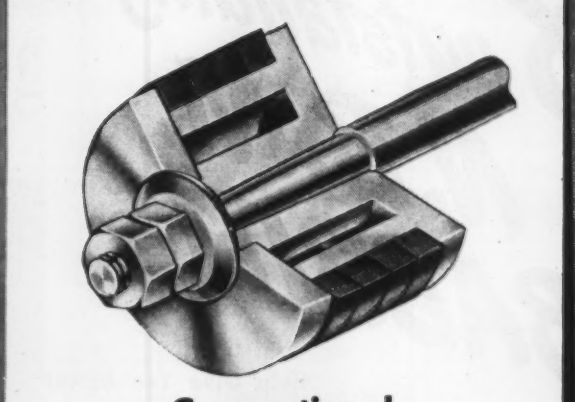
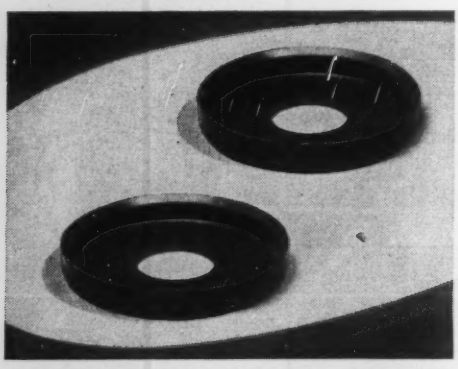


Johns-Manville Moulded Packing Cups



Conventional type piston packing

— Which does the better job?



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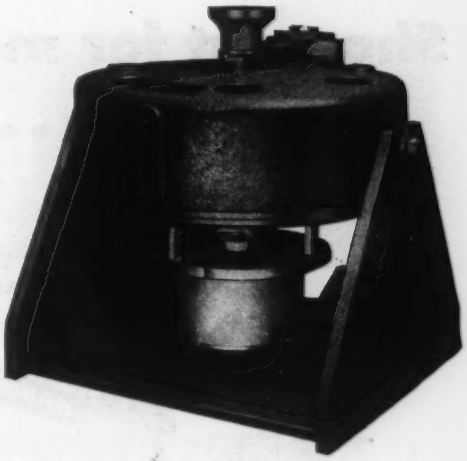
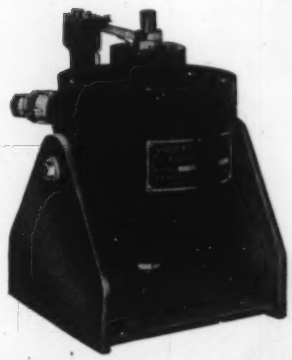


You can save time, eliminate tedious calculations, and improve your product with the help of an MB electromagnetic shaker. Note how these benefits add up in the following typical applications – just three of many uses for this quality-control and research "tool."



MODEL SA VIBRATION EXCITER Delivers 5 pounds force from 20 to 1,000 c.p.s., usable to 20,000 c.p.s.

INDEFATIGABLE FATIGUE TESTER – Here is the endurance tester to show up *quickly* those faults which often result in failures under dynamic stresses. Why risk trouble reports? You can shake such parts as axles, brackets, complete assemblies, housings, castings and make improvements *before* full scale production – *before* the remedy becomes costly.

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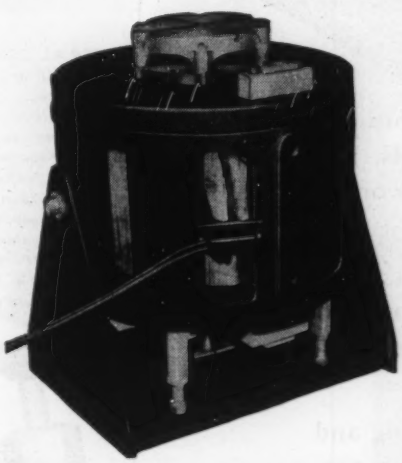
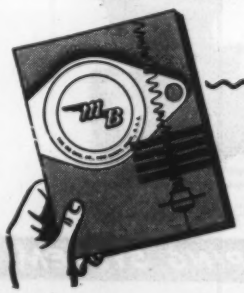
SHAKE OUT THE "BUGS" – Electrical and sensitive components can be checked for ability to withstand severe vibratory service conditions. Reproduce the effect of years of vibration on your product within *hours!*

You'll find MB Vibration Exciters at work for many leading companies recognized for the quality of their engineering. Would you like to know how to apply one to your *own* problems? An MB engineer will be glad to show you—without obligation.



MODEL S3 VIBRATION EXCITER Delivers controlled force up to 200 pounds, in frequency range of 3 to 500 c.p.s.

Testing of small turbine blades (encircled) mounted on an MB Model C-1 Exciter which delivers 25 pounds force in range of 4 to 500 c.p.s. (and higher). Using stroboscopic lighting, resonances and deflections are studied *visually* – and any need for corrections determined quickly. A stronger, stiffer blade is sure to result.



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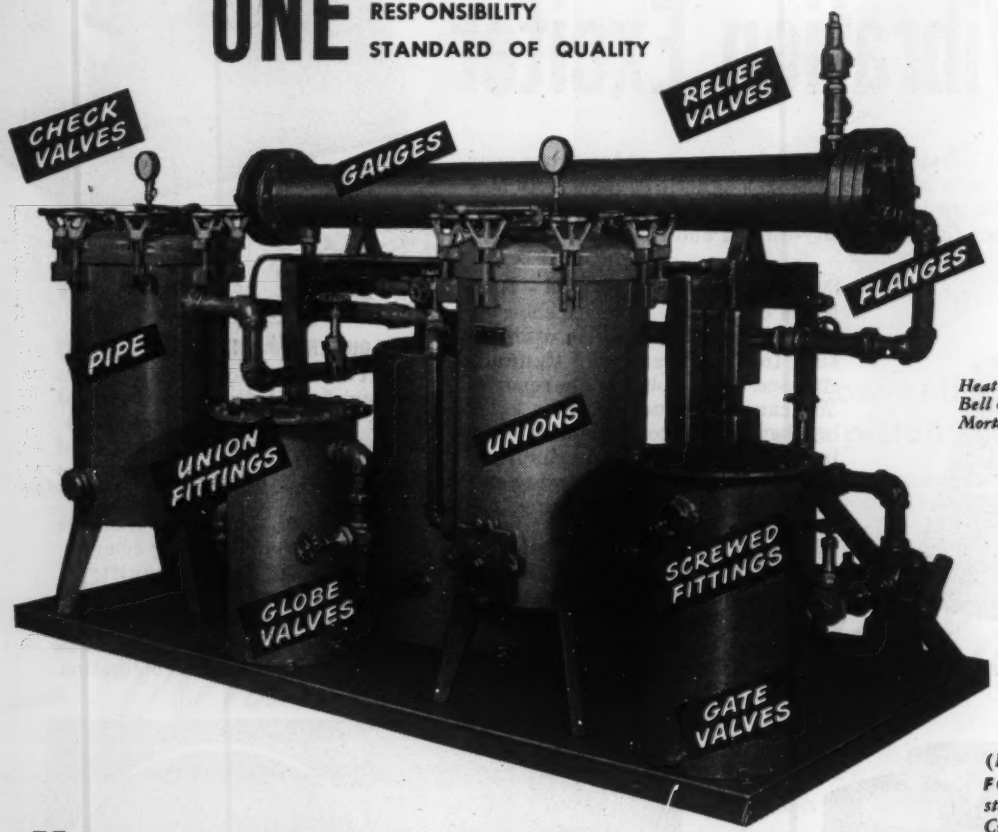

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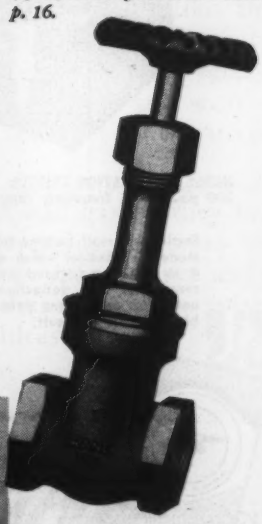

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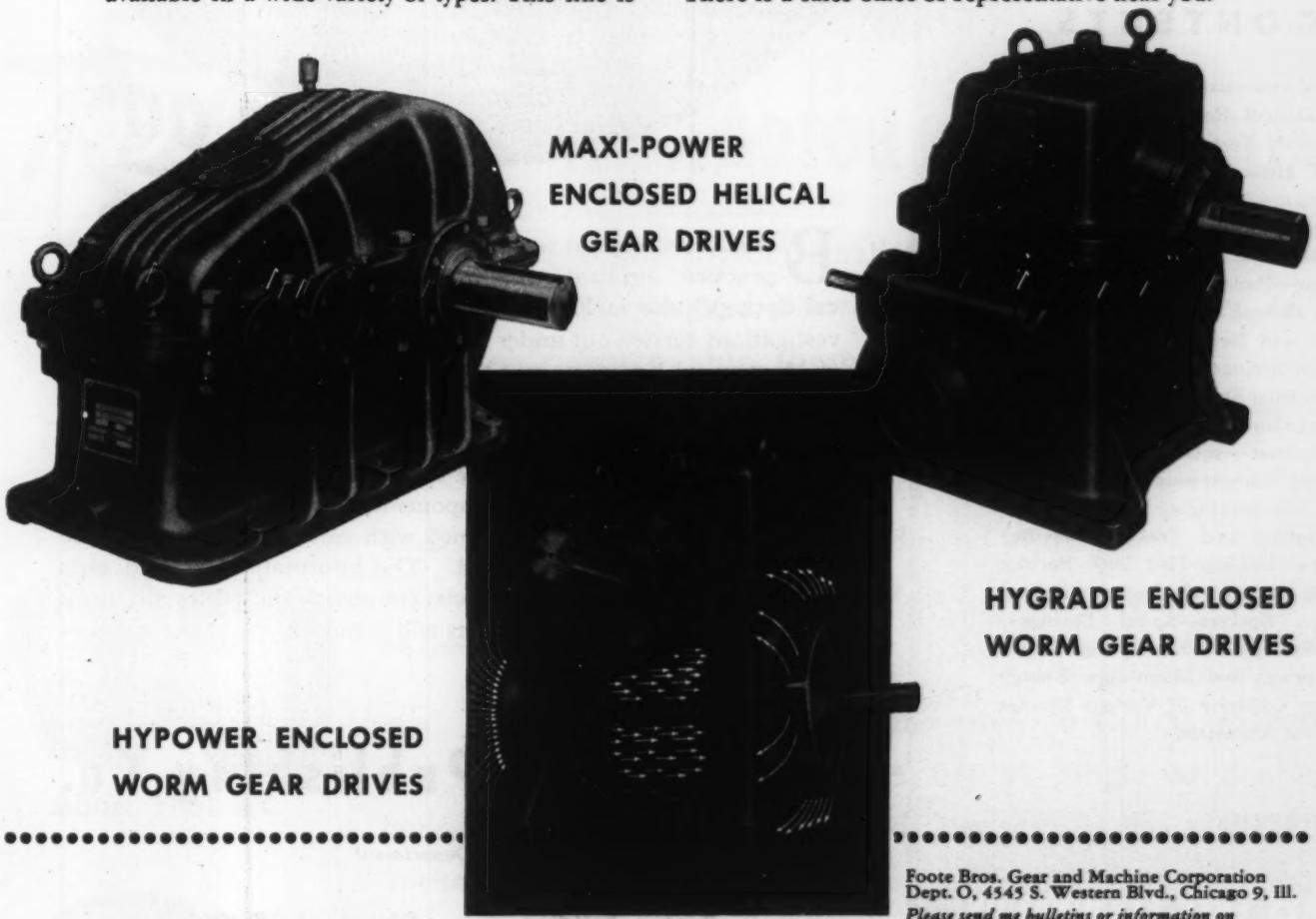

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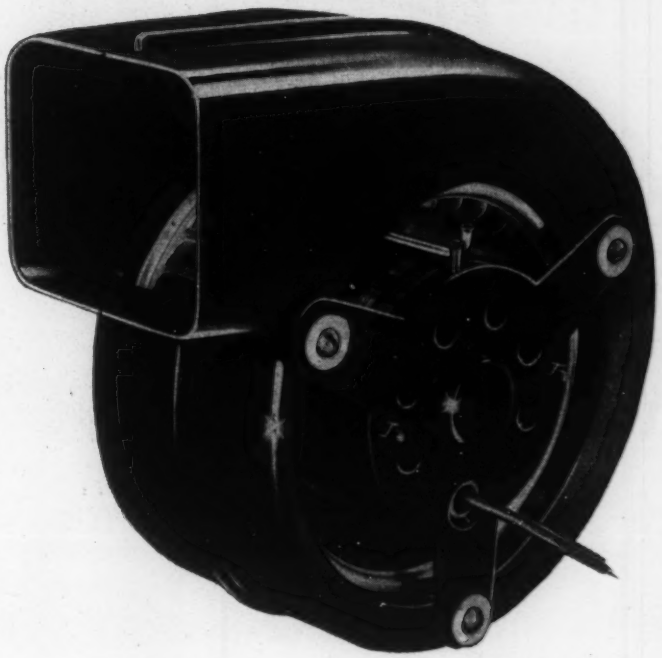

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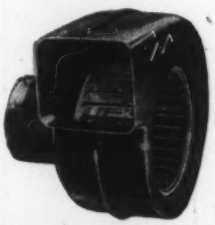

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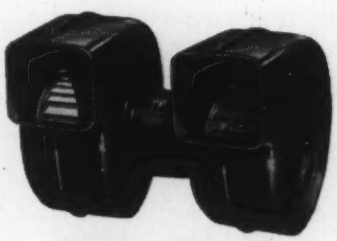

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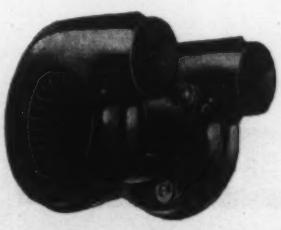

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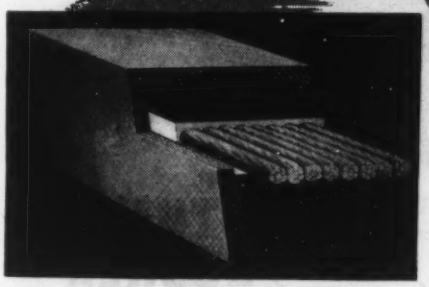

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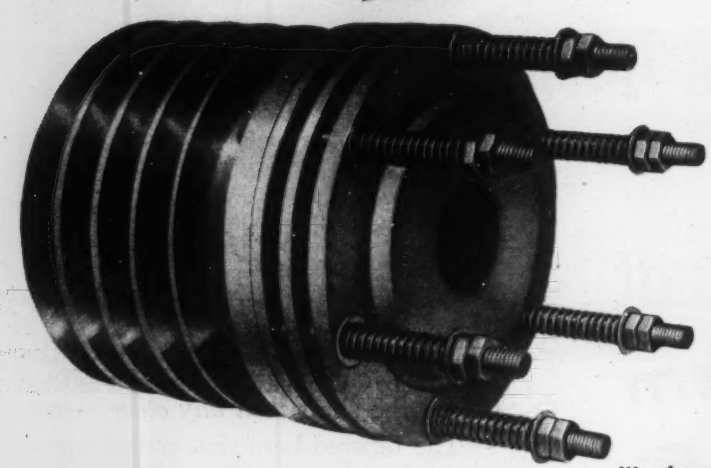

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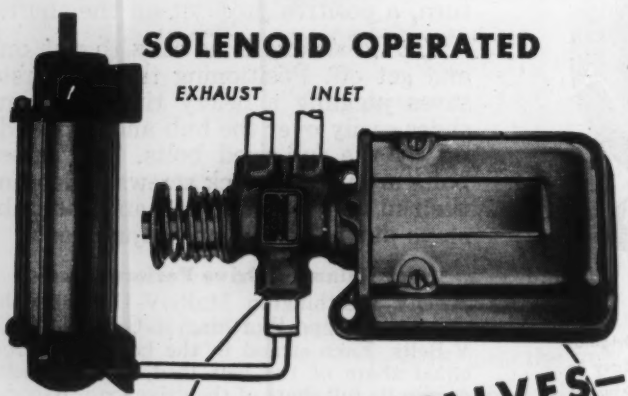

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VALVAIR CORPORATION • 454 Morgan Avenue, Akron 11, Ohio
AFFILIATE: SINCLAIR-COLLINS VALVE CO.

Rely upon Valvair

Photo Courtesy G. A. Gray Co.

LOWER COSTS!

Specify

RUTHMAN GUSHER
COOLANT PUMPS
On metal cutting machines

Illustrated is a 11022-E ¾ HP Ruthman Gusher Coolant Pump on a Gray 8' 175-ton Planer Type Horizontal, Boring, Drilling, & Milling Machine.

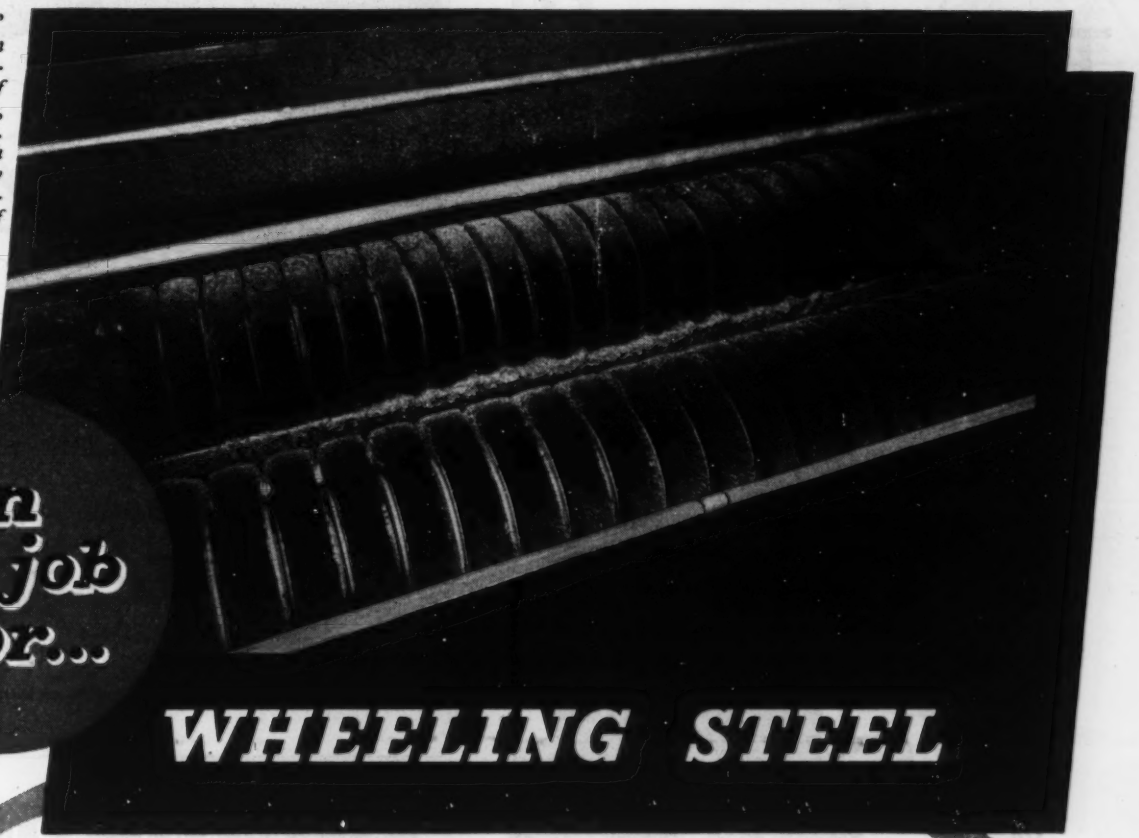
You lower costs three ways when you specify Ruthman Gusher Coolant Pumps on your machines.

- They cost less to operate, use less power when throttled.
- They are precision-built to give you longer life at lower maintenance cost.
- They are more efficient, give you split-second coolant flow from a trickle to full volume.

Write now for Catalog.

THE RUTHMAN MACHINERY CO.
1811 READING ROAD CINCINNATI, OHIO

"PITTSBURGH" *Power Driven* BRUSHES



A "Pittsburgh" power-driven brush in operation at the Steelcrete Division of Wheeling Steel, Beach Bottom, W. Va. This special brush is on the job every day deburring and cleaning large sheets of Expanded Metal.

On the job for...

WHEELING STEEL

Pittsburgh's ingenuity in designing special brushes for unusual jobs is sought time and time again by leading firms in almost every industry. Wheeling Steel, for example, recently put its brushing problem before Pittsburgh's staff of skilled brush engineers.

Selecting a .014 steel wire with pre-tested fast cutting qualities, Pittsburgh engineers designed and built a *Perfect Balance* rotary brush that could take a beating and come right back for more. The brush was *stiff* enough to remove stubborn burrs. It was *tough* enough to penetrate and thoroughly clean the metal. And it was *soft* enough not to impair surface texture.

The brush did the job right from the first day it was put into operation—another example of Pittsburgh's ability to cope with the most difficult brush problems.

There's a "Pittsburgh" Brush for Every Industrial Use!

- GLASS
- STEEL
- PLASTICS
- AUTOMOBILE
- RUBBER
- PAPER
- TIRE and RETREADING
- SHOE MANUFACTURING and REPAIRING

In the complete Pittsburgh line are brushes of all types, including "Perfect Balance" sections, wheels and assemblies. Consult the Pittsburgh engineering representative. He will gladly work with you in developing any type of power-driven brushes to meet your particular finishing specifications.

Phone or write Pittsburgh Plate Glass Company, Brush Division, 3221 Frederick Ave., Baltimore—29, Maryland

Power Driven BRUSHES

PPG BRUSHES · PAINT · GLASS · CHEMICALS · PLASTICS

PITTSBURGH PLATE GLASS COMPANY

HIGH TORQUES?

DE LAVAL SPEED REDUCERS

For low final speeds Worm Gear Speed Reducers should be selected on the basis of output torque ratings.

If your problem is to select a gear reducer capable of carrying high torques, consult De Laval, either directly or through a sales representative.

ONE OF 93

This double reduction De Laval Worm Gear Speed Reducer is available with many standard gear ratios and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

SEND FOR CATALOG 50-11-D

Worm Gear Division

DE LAVAL

De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

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• Imperial Pencil Tracing Cloth has the same superbly uniform cloth foundation and transparency as the world famous Imperial Tracing Cloth. But it is distinguished by its special dull drawing surface, on which hard pencils can be used, giving clean, sharp, opaque, non-smudging lines.

Erasures are made easily, without damage. It gives sharp, contrasting prints of the finest lines. It resists the effects of time and wear, and does not become brittle or opaque.

Imperial Pencil Tracing Cloth is right for ink drawings as well.

IMPERIAL PENCIL TRACING CLOTH

SOLD BY LEADING STATIONERY AND DRAWING MATERIAL DEALERS EVERYWHERE

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BETTER SHEAVES FOR BETTER DRIVES

BROWNING Gripbelt Sheaves With Split Taper Bushings

Be sure to check Browning's new low prices before you buy.

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BROWNING MANUFACTURING COMPANY
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MAYSVILLE, KENTUCKY

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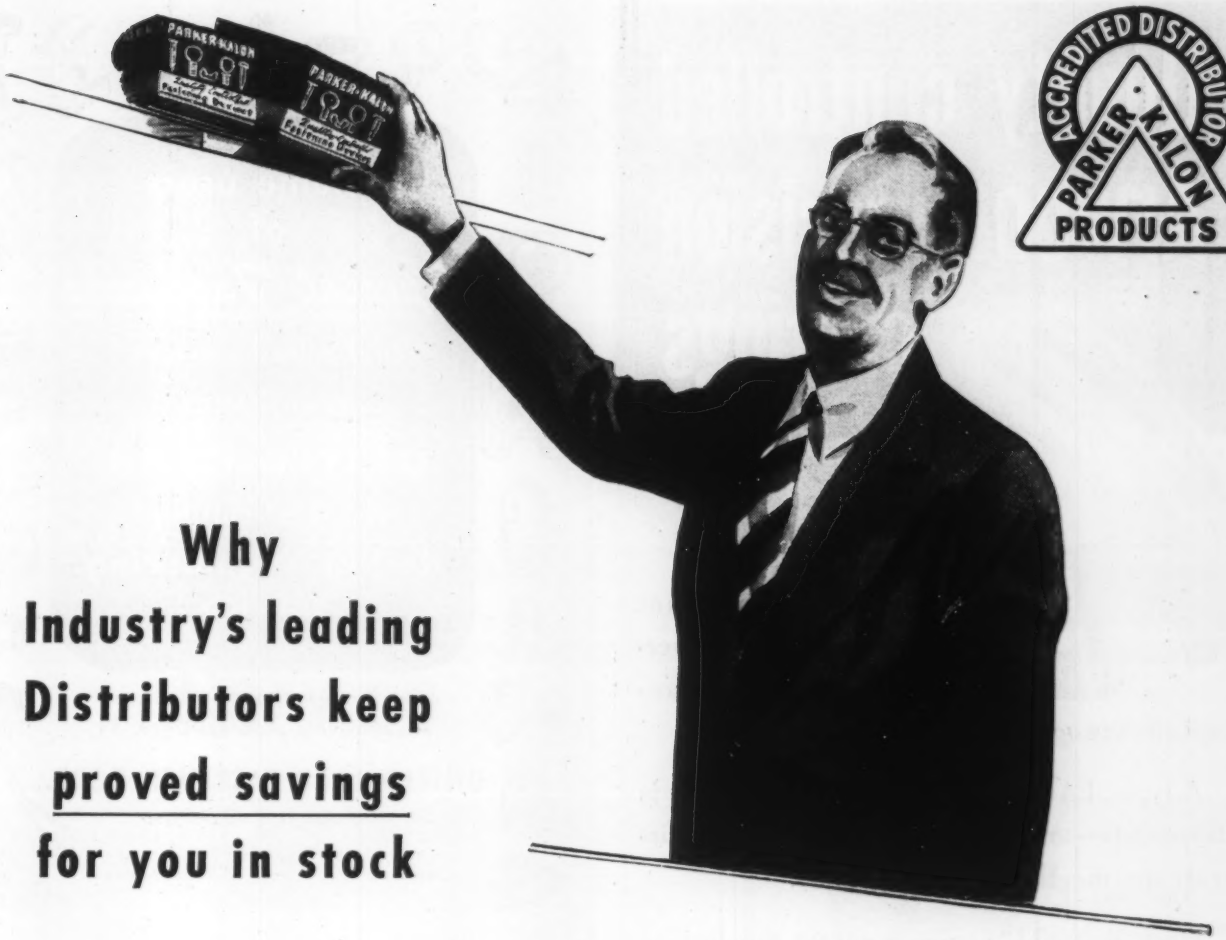


ACCREDITED DISTRIBUTOR
PARKER · KALON
PRODUCTS

Why Industry's leading Distributors keep proved savings for you in stock

Your Distributor's stock of P-K Self-tapping Screws is a shelf full of savings for you. When you order, he delivers not simply screws, but a proved means of lowering assembly costs . . . as much as 50% or more.

Wherever your plant is located, in the United States or Canada, there's a Parker-Kalon Distributor nearby, ready to give you quick, helpful service. And you'll find he's the leading Distributor in your area, because, keenly aware of industry's needs, he offers those products which sell best because they serve most.

That's why he stocks and sells P-K Self-tapping Screws. He knows that, when you choose P-K, you get *more "know-how"*—Parker-Kalon originated the Self-tapping Screw and has been the leader with new designs ever since . . . *more "show how"*—P-K's staff of Assembly Engineers has helped solve nearly a million application problems . . . *more choice of types and sizes*—with a complete line of Self-tapping Screws for every metal and plastic assembly, P-K's advice is unbiased . . . *more exacting quality control*—P-K's investment in laboratory testing and inspection equipment is unsurpassed . . . *more production*—Parker-Kalon is the world's leading manufacturer of Self-tapping Screws.

Let a P-K Assembly Engineer help you find out how you can simplify assemblies, improve strength, save time, and lower production costs with the simpler P-K method. If you prefer, mail assembly details for recommendations. Parker-Kalon Corporation, 200 Varick St., New York 14, N. Y.

REMEMBER . . . IF IT'S P-K . . . IT'S O.K.!

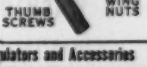
P-K®

The Original

PARKER-KALON SELF-TAPPING SCREWS

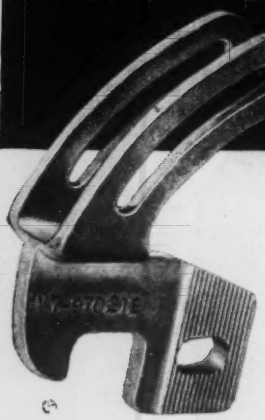
FOR EVERY METAL AND PLASTIC ASSEMBLY

P-K Also Makes Cold-forged



OTHER P-K PRODUCTS: Cold-Forged Socket Screws, Wing Nuts, Thumb Screws • Hardened Screwnails and Masonry Nails • Shur-Grip File and Solder Iron Handles • Metal Punches • Damper Regulators and Accessories

Quality controlled Arwood precision castings



When your product needs peak casting performance, take advantage of Arwood's Quality Control.

A typical Arwood Casting for aircraft use is illustrated—tolerances of ±.005 and rigid aircraft specifications are maintained.

Steel die molds assure accurate dimensions and sharp serrations.

Metal soundness is assured by X-ray and Magnaflux controls, physical and chemical certifications.

Arwood Precision Investment Casting is now a tested and important method for producing small intricate parts. It has been the answer to many design and production problems and can be the answer to yours.

For additional information about Precision Castings write for our new booklet, "A Critical Survey of Investment Castings".

ARWOOD

PRECISION CASTING CORP.

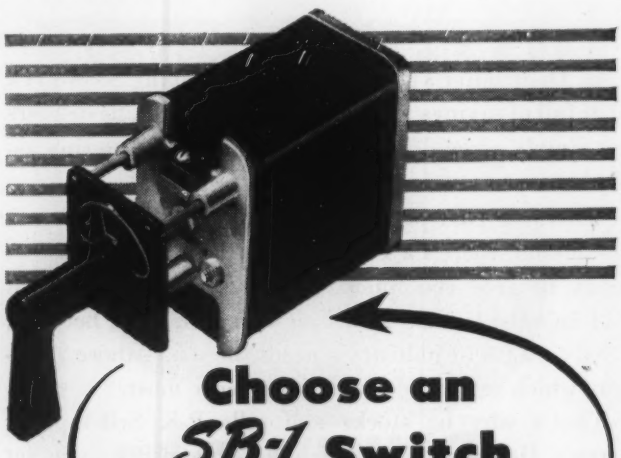
79 WASHINGTON STREET • BROOKLYN 1, N. Y.

Send us your specifications or requirements. Address Dept. 11

UNITED-CARR FASTENER CORP.

Cambridge 42, Mass.

MAKERS OF DOT FASTENERS

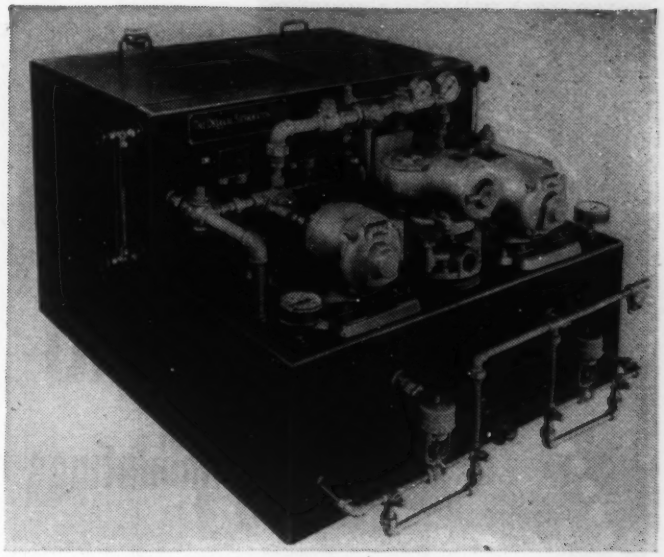


YOU can use this versatile switch on practically any circuit for practically any job—over 10,000 circuit-sequence combinations are possible. Rated up to 20 amperes at 600 volts a-c or d-c. Compact, sturdy construction. Mount on panels ⅛ to 2 inches thick. Easy to order, too . . . see your G-E sales representative about the SB-1. Write for Bulletin GEA-4746. *Apparatus Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

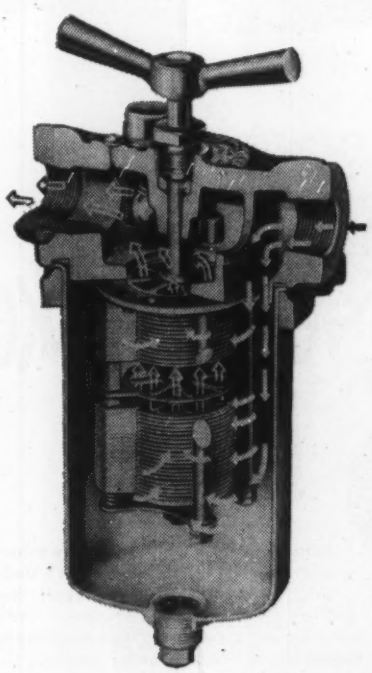
856-19

DeLaval Separator Company uses Cuno AUTO-KLEAN filters to condition for reuse the oil in its pressure lubricating systems. Single motor-driven cartridge, built into the unit, continuously removes contaminants from full flow of recirculating oil . . . with no stops for filter-cleaning.



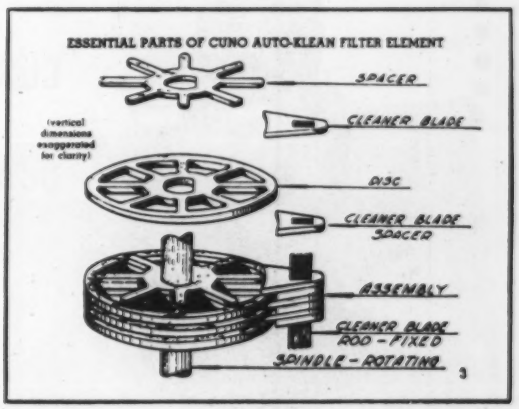
Non-stop Laundry Service

for Lubricating Oils



Single compact unit—no larger than usual partial-flow type—handles full flow of practically any fluid. Filtering element is permanent, all-metal, disc-type cartridge.

● Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and *after* installation, service based on years of experience with engineering filtration systems.



Continuously cleanable feature permits single unit installations. Can be cleaned periodically by hand or continuously by motor drive, without shutting down operation.

Built-in or Externally Mounted

Cuno Auto-Klean Filters are available for built-in or external installations, in sizes handling from a few to more than 4000 gpm.

Send Coupon

FOR FREE INFORMATION ON CUNO CLEANING

Cuno Engineering Corporation
204 S. Vine St., Meriden, Conn.
Please send information on Cuno Filter.

Name.....

Position.....

Business Address.....

PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

CUNO

Fluid Conditioning

Removes More Sizes of Solids from More Types of Fluids

MICRONIC • DISC-TYPE • WIRE-WOUND

LORD mountings give "cushioned power"

THE unique design of the Salsbury Turret Trucks posed an unusual problem. The entire weight of the power plant assembly is carried by the single front wheel and turns with it in a complete 360° radius, riding on sheave-type rollers over a steel band.

Six Lord Tube Form Mountings serve the triple function of taking a vertical load; elimination of flat spots on the circular band, due to disproportionate wear of the sheave-type rollers; and softening the shock due to draw bar pull. The engine itself is mounted on four large Plate Form Mountings to absorb the high frequency vibration.

Salsbury Turret Trucks furnish another instance of the versatility of Lord Vibration Control Systems in the solution of unusual as well as normal vibration problems.

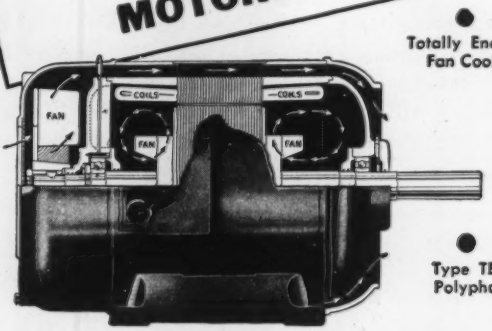
See our bulletin in Sweet's 1949 File for Product Designers or write for Bulletin 900 today. It describes the complete line of Lord products and services.

LORD MANUFACTURING COMPANY, ERIE, PA.

Canadian Representative: Railway & Power Engineering Corp. Ltd.

LORD Vibration Control Systems

THE LATEST DEVELOPMENT in AIR COOLED Ball Bearing MOTORS



Here is the newest and most successful development in air cooled motors. Totally enclosed, constant speed, continuous duty; it is designed for cooler and more economical operation under the hardships of extreme heat and dust. Fully ball bearing and quiet running, too. You will want to know more about this *new* VALLEY Motor.

WRITE FOR DESCRIPTIVE LITERATURE

VALLEY ELECTRIC CORPORATION

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Can't Shake Loose...

Standard's Locknuts and Lockwashers are made to stay . . . you can't shake them loose. They're easy to apply, durable, and can be used again and again. Order Standard Locknuts, Lockwashers, and Adapters for your application of ball and roller bearings . . . S.A.E. Standard, A.B.E.C. Standard, Heavy-duty and Specials.

Locknuts in sizes N-00 through AN-40 . . . Multi-prong Lockwashers in sizes W-00 through W-40 . . . Adapter sizes 7-9-11-13 for shaft sizes $1\frac{3}{16}$", $1\frac{7}{16}$", $1\frac{15}{16}$", $2\frac{9}{16}$" . . . standard shaft collars, sizes $\frac{1}{2}$", $\frac{5}{8}$", $\frac{3}{4}$", $\frac{7}{8}$" and 1". Order now from our complete stock.

Standard

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Speer Carbon Brushes

REFLECT

thousands of brush specifications

U.S. PAT. 2,181,067

A half century of research and testing to develop the most serviceable brush characteristics for a wide range of applications has provided Speer with specifications for several thousand brush grades. Conversion of this large assortment to a smaller number, with superior operating characteristics passed down, makes Speer's standard line of carbon brushes actually the best of the best. A good reason for you to specify Speer Carbon Brushes for all your commutating jobs, whatever your requirements.

4747

Speer

CARBON COMPANY
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brushes • contacts • welding electrodes • graphite anodes • rheostat discs • packing rings • carbon parts

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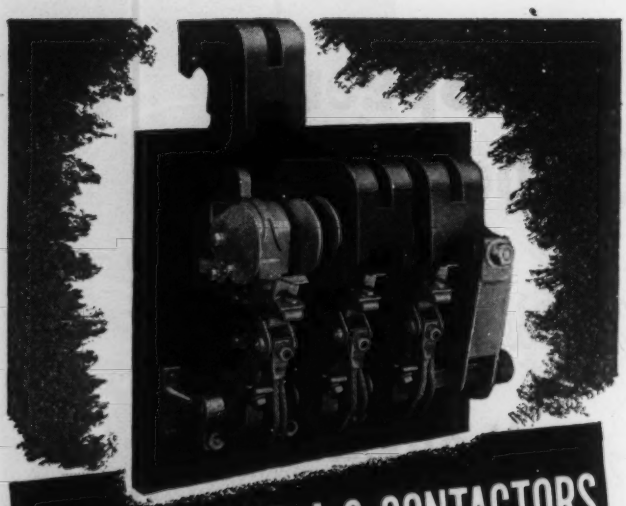


MAKE SURE YOUR A-C CONTACTORS PASS THIS TEST

100 amp. contactor illustrated	E. E. Contactors	Other Contactors
1 Stamped-steel, welded construction assures extra strength.	✓	
2 Light-weight, fast-moving parts provide quick operation. No die-cast parts	✓	
3 Self-lubricating, porous-bronze bearings.	✓	
4 Extra-wide, heavy-duty contacts (¾").	✓	
5 Compact design . . . lessens required mounting space.	✓	
6 Lift-off arc shields for quick contact inspection.	✓	
7 Standard electrical interlock has n.o. and n.c. contacts - electrically separate	✓	
8 Stainless-steel springs on both main and auxiliary contacts.	✓	
9 Arc-centering design . . . assures longer arc-shield life.	✓	
10 Unusually high rupturing capacity. Highly efficient blow-out system.	✓	

Make these ten, top-priority features the guideposts in selecting A-C Contactors. You'll find Euclid Electric Contactors thrive on comparison because *only* Euclid offers all ten. *Plus* sound design, *plus* precision workmanship, *plus* 27 years of experience that make E.E. the leader in motor-control apparatus.

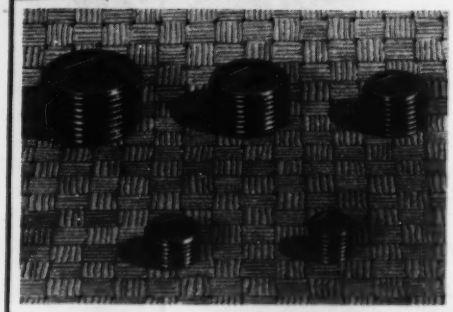
Ask your E.E. Representative for more information, or write:

The Euclid Electric & Mfg. Co.
MADISON, OHIO

TOUREK

announces its new line of PRECISION-MADE

STEEL PIPE PLUGS



Accurate . . . High Strength . . . Economical!

Tourek's new line of standard countersunk pipe plugs gives you the favorable physical characteristics of specially selected steel in combination with precision automatic screw machine production—resulting in the highest quality at costs which are competitive to old style plugs.

Standard stock sizes, available with National Pipe or Dry-Seal threads are: ¼", ⅜", ½", ¾" and 1".

Tourek pipe plugs are available on special order in alloy steels, aluminum or brass in sizes up to 2⅝" diameter.

Send today for literature which gives complete specifications.

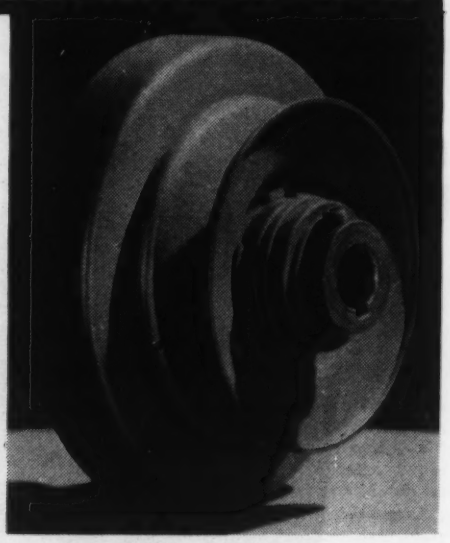
MAKERS OF QUALITY SCREW MACHINE PRODUCTS

J. J. TOUREK MFG. CO.
4701 W. 16th St., Chicago 50, Ill.

ESTABLISHED 1920
TOUREK
FAMOUS BALL JOINTS

PUT A MERCURY CLUTCH ON THE JOB

EASY STARTING FOR MOTORS & GASOLINE ENGINES



A Mercury Clutch provides smooth, safe starting for any electric motor from ¼ H.P. up to 25 H.P. By retarding the application of the load until the motor has achieved full speed, a Mercury Clutch prevents overloading of the circuit and eliminates fire hazards. With a Mercury Clutch on the job there is no danger of burned-out wiring, blown fuses, flickering lights, etc. On gasoline engines a Mercury Clutch insures load-free starting and idling. Write for information.

Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS, INC. · CANTON 6 · OHIO

44,000,000

PHOENIX
ARIZ.

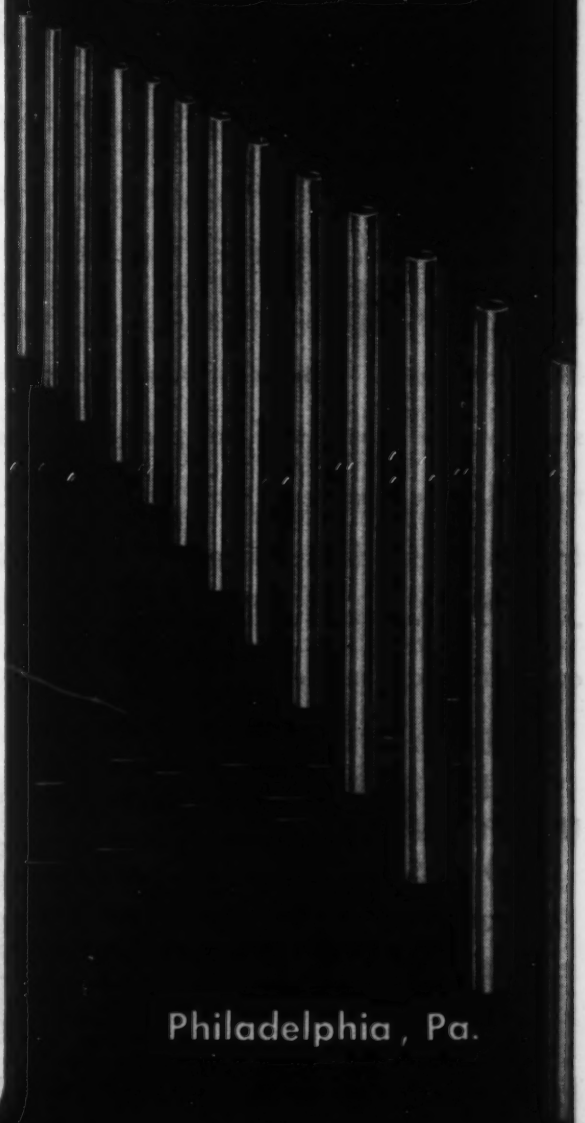
TUBES

. . . IDENTICAL TO 0.001"

Modern mass production methods of the BB Pen Company of Hollywood, California, require ink cartridges held within strict dimensional tolerances: plus 0.0015" minus 0.0000" O.D.; plus 0.001" minus 0.000" I.D. Precision Tube Company has already supplied 44,261,000 brass tubes for these cartridges which, if laid end to end, would stretch from Philadelphia, Penna., to Phoenix, Ariz., and every one identical within the specified tolerances.

This Parade of Precision is possible only through highly specialized quality control—the same control used for the sizes, shapes, alloys, and finishes you specify. Contact Precision when you need non-ferrous tubing from 0.500" O.D. to 0.010" O.D. . . . wall thicknesses down to 0.0015".

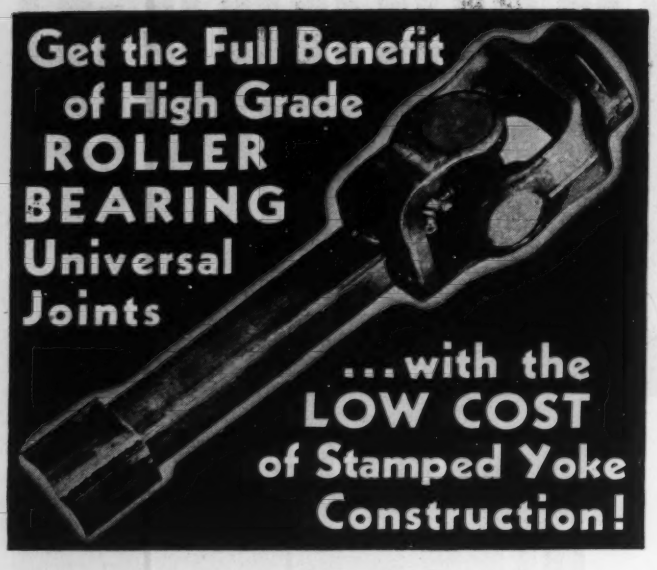
When Precision Counts . . .
Count On Precision



Philadelphia, Pa.

PRECISION TUBE CO.

3824-26 TERRACE STREET PHILADELPHIA 28, PA.

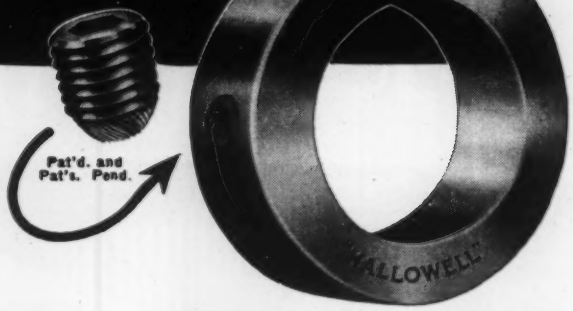


Your high grade machines deserve MECHANICS Roller Bearing UNIVERSAL JOINTS high quality. And now you can benefit from the protection and convenience of "once-a-season" or "lifetime" lubricated *roller bearing* universal joints — and still have the economy of stamped yoke construction. Let our engineers show you how this new MECHANICS Roller Bearing UNIVERSAL JOINTS development will give *your* machines competitive advantages.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner BW
2032 Harrison Avenue
Rockford, Illinois

MECHANICS
Roller Bearing
UNIVERSAL JOINTS
For Cars · Trucks · Busses and Industrial Equipment

HALLOWELL
Steel Collars



"HALLOWELL" Solid Steel Collars, functionally proportioned throughout . . . precision-machined so faces run perfectly true . . . are beautifully polished all over . . . yet they cost less than common cast iron collars. 3" bore and smaller are made from Solid Bar Stock. To make sure the collar won't shift on the shaft, they are fitted with the famous "UNBRAKO" Knurled Point Self-Locking Socket Set Screw—the set screw that won't shake loose when once tightened. "HALLOWELL" . . . a "buy word" in shaft collars . . . available in a full range of sizes for

IMMEDIATE DELIVERY

Write for name and address of your nearest "HALLOWELL" and "UNBRAKO" Industrial Distributors.

OVER 46 YEARS IN BUSINESS

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNSYLVANIA BOX 102
CHICAGO - DETROIT - ST. LOUIS - SAN FRANCISCO

FEED SCREWS
FOR EVERY PURPOSE
• TOUGH • CORROSION-RESISTANT
• ABRASION-RESISTANT • SMOOTH
STREAMLINED, HOMOGENEOUS STEEL CASTINGS
COST LESS!
We definitely guarantee deliveries on time.
We can handle emergency orders.

CALUMET STEEL CASTINGS CORP.
1636 SUMMER ST. • HAMMOND, IND.

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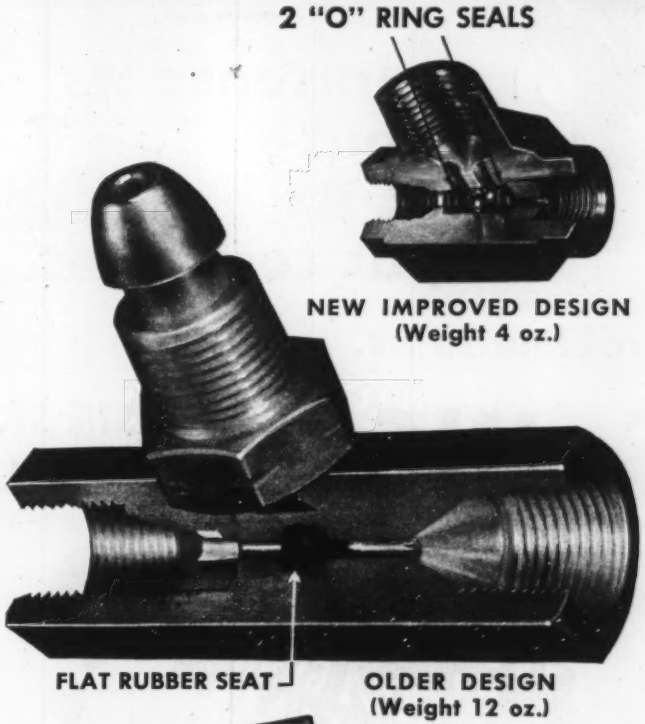
USE "O" RING SEALS

(The modern packing method)

for SIMPLICITY · RELIABILITY · LOW COST · SPACE SAVINGS

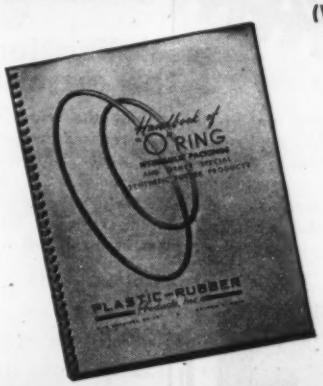


This new Cross Check Tee which is a part of an Automatic Gas Regulator made by THE WEATHERHEAD COMPANY of Cleveland, Ohio uses two "O" Rings as the seats for a stainless steel ball.

Note the small compact design. The new tee has the same rated gas flow as the older type tee shown below. (The photographs are in correct proportion.) The "O" Rings seal the ball under the slightest differential pressures. The unit is noiseless and shuts off perfectly when the gas line is disconnected from either side of the tee. The unit is not only smaller but much cheaper to manufacture.

These tees are used on propane-butane liquefied petroleum gas. Special synthetic rubber compounds have been developed for this service which insure long life and trouble-free service.

PRP Field Engineers will welcome the opportunity of discussing possible applications of "O" Ring Seals to your products now in design or in production.



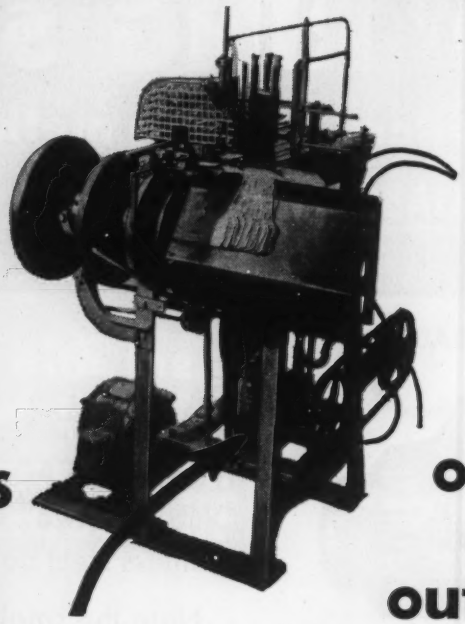
● **Investigate "O" Ring Seals. Consult the "O" Ring specialists. Send for our "O" Ring Handbook. It's free.**

PLASTIC and RUBBER Products, Inc.

Box 431, Dayton 1, Ohio

LEIMAN BROS. ROTARY VACUUM PUMPS

Operate on Automatic Machines

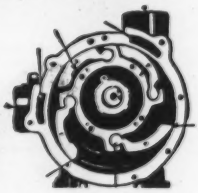


A Tag Stringer Machine or Whatever You Have

Down Go Costs

Up Go Profits!

Increase its output— cut its output cost



Submit your problem to us.

LEIMAN BROS. INC.

162 CHRISTIE ST.
NEWARK 5, N. J.

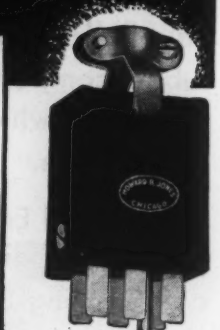
For HIGHEST ELECTRICAL & MECHANICAL *Efficiency!*

New

JONES 2400 SERIES PLUGS & SOCKETS

Improved Socket Contacts. Four individual flexing surfaces. Positive contact over practically their entire length.

Both Plug and Socket Contacts mounted in recessed pockets greatly increasing leakage distance, INCREASING VOLTAGE RATING. Plug and Socket Contacts cadmium plated. Add to appearance of your equipment. Interchangeable with Jones 400 Series.



P-2406-CCT
Plug — with cable clamp in top.

S-2406-SB
Socket with shallow bracket for flush mounting.

Ask for Catalog 17, Complete line Jones Plugs, Sockets, Terminal Strips.

HOWARD B. JONES DIVISION
Cinch Mfg. Corp.
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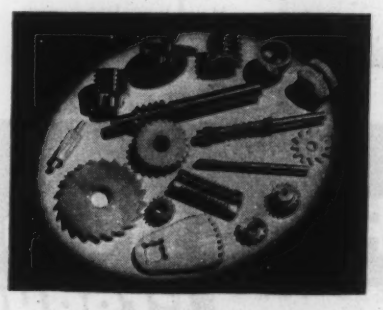
Yes, experienced specialization on producing not the most gears, but *better* gears . . . accurate, dependable, uniform . . . cut exactly to your particular specifications. Whether your order is for a few hundred or many thousands . . . standard or special . . . Abart's modern, highly developed production methods will give a degree of craftsmanship which is unsurpassed . . yet the cost will be very moderate. NO STOCKS. Put your gear problem in the hands of specialists—*Put It To Abart.*



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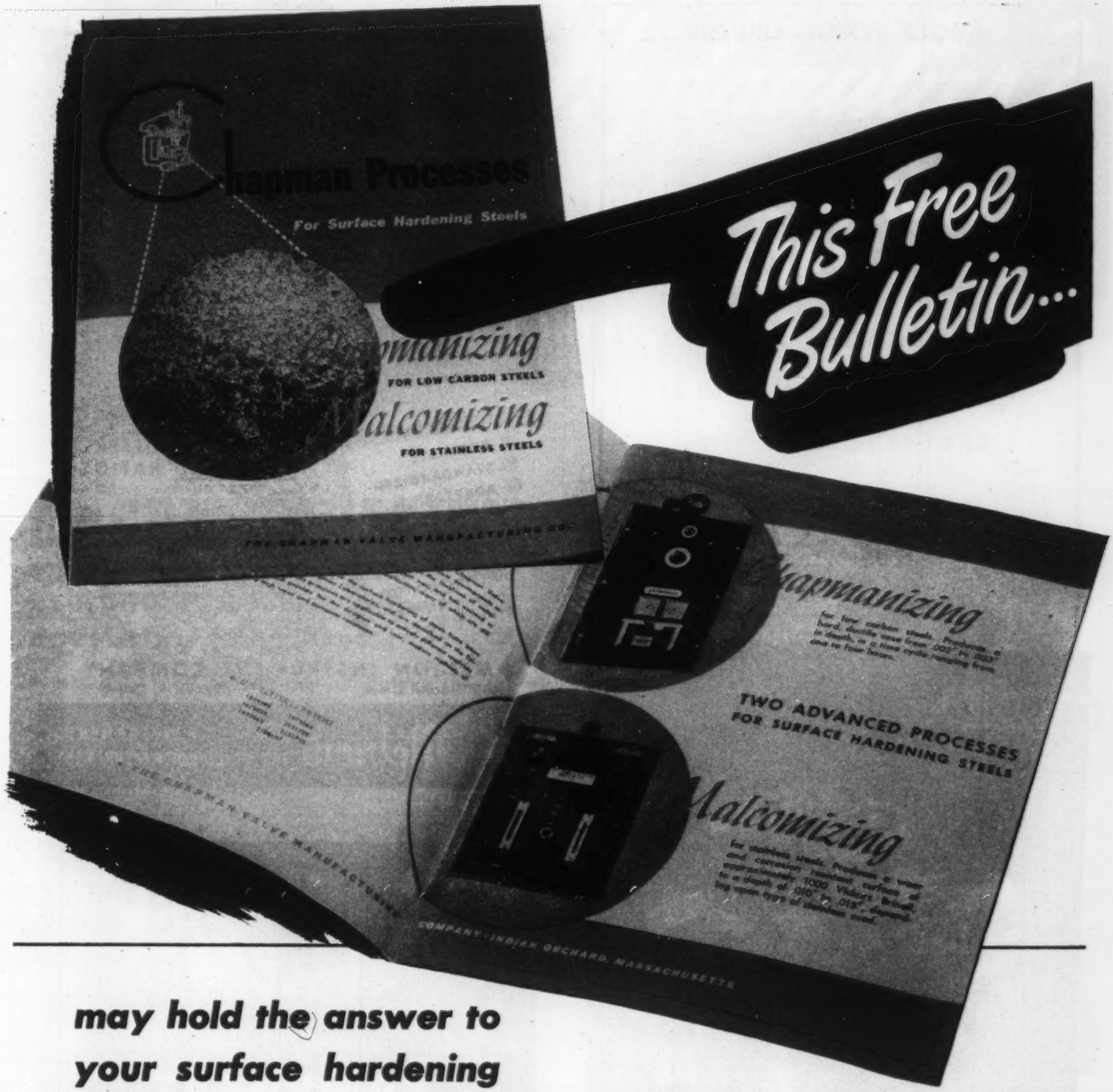
Abart GEAR & MACHINE CO.
4821 W. 16th St., Chicago 50, Ill.



may hold the answer to your surface hardening problems

In this bulletin—*yours for the asking*—there's a compactly-told story on two modern surface hardening methods—*Chapmanizing* and *Malcomizing.* Both are important to anyone interested in longer-wearing parts.

CHAPMANIZING produces an alloy-like case (from .002" to .035" in depth) on low carbon steels in only 1 to 4 hours. It's a tough, ductile case that will not chip or check. And it's ready for use with minimum finish grinding, for the surface comes out silver-clean.

MALCOMIZING gives stainless steels a case that ranges in depth from .005" to .015". Hardness approximates 1000 Vickers Brinell. Finish grinding or lapping is possible, for maximum hardness is slightly below the surface.

If you would like the full story on these two widely used hardening processes, just fill in and mail the coupon.

Metallurgical Sales Division of
THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASS.

Metallurgical Sales Division of
The Chapman Valve Manufacturing Co.
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Please send me your booklet on CHAPMAN PROCESSES and the name of the nearest commercial heat treater who can *Chapmanize* ☐ *Malcomize* ☐ for me.

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Company.....

Street.....

City.....*State*.....

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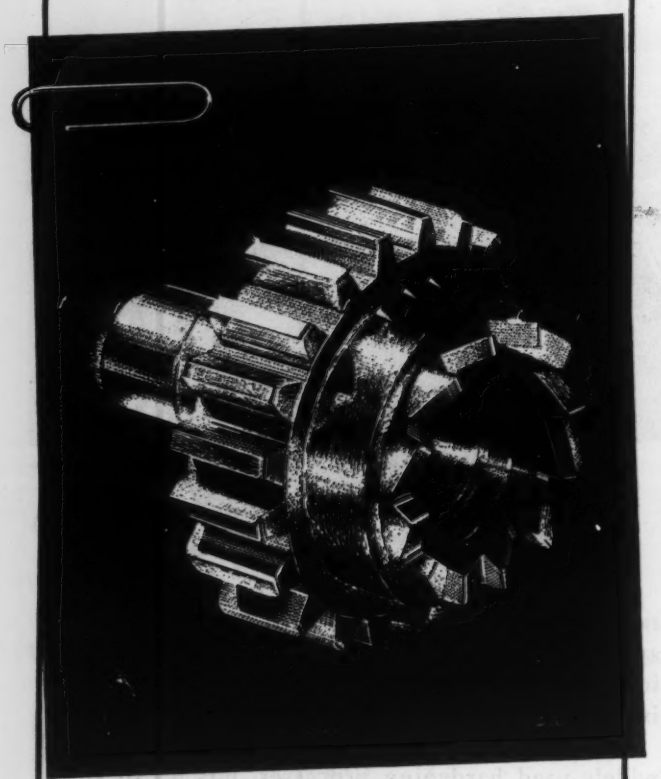
TO: Advertising Dept.

The attached scratchboard drawing is good -- but you still don't show the detail and precision that we build into these gears.

John L. Buehler



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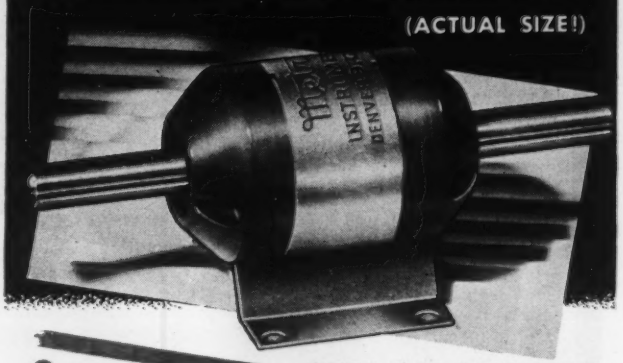
(ACTUAL SIZE!)



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...for large volume hydraulic Systems

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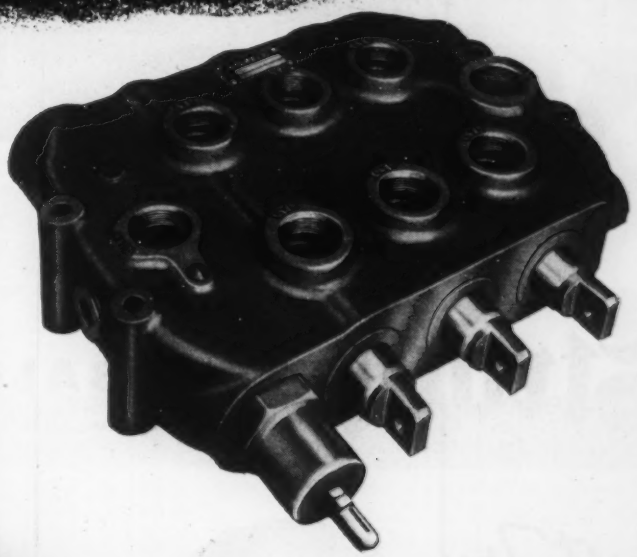
HYDRAULIC CONTROL VALVES



80 GPM CAPACITY

at 1000 P. S. I. recommended operating pressure...

• HYDRECO V8 Series Control Valves are the answer for large volume hydraulic control systems that require precision control. Models are available for controlling one to three single or double-acting plungers.

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Three plunger V8 Series HYDRECO Valves provide fast and accurate hydraulic control of cutting blade and conveyor belt on this Euclid BV Loader, manufactured by the Euclid Road Machinery Company, Cleveland, Ohio. Here is a big job, easily handled by HYDRECO V8 Series Valves.

V8 Series Valves have ample capacity to handle the large volume of oil required in this hydraulic control system, and at the same time provide the precision necessary in the adjustments of the cutting blade for angle and depth of cut. Instant control of belt movement is also provided.

Quality in design... *Quality* in product

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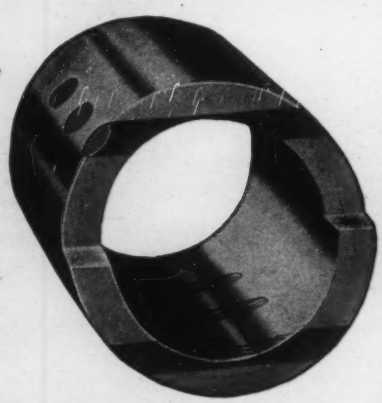

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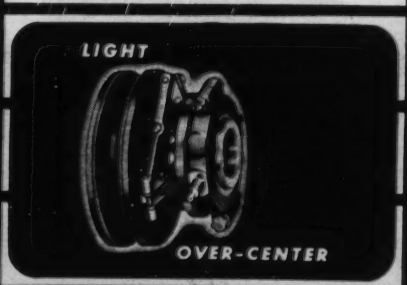

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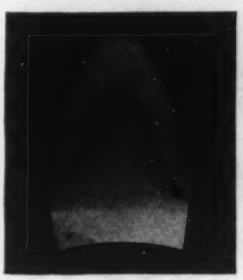
this "taper-hardened" tooth bends before it breaks



Taper-Hardened Tooth Section

Case-Hardened Tooth Section

The taper-hardened tooth above bent under the same force that snapped the case-hardened tooth. Yet a test will show wearing surfaces of nearly equal hardness.

The cross sections at the left show why taper-hardened gears have resilience and life under their hard surfaces—why they last longer in punishing service—why they "roll with the punch". Notice the graduated hardness in the taper-hardened tooth—blending down the scale from maximum hardness at the surface to toughness at the ductile core. Compare it with the thin, brittle, shell-like hardness of the case-hardened tooth in which there is no give, no bend.

No wonder "taper-hardened" BP gear steel makes gears last so long.

For complete information on taper-hardening, write for free copy of "BP Gear Steel" B-4395, Westinghouse Electric Corp., Dept. 49, P. O. Box 868, Pittsburgh, Pa.

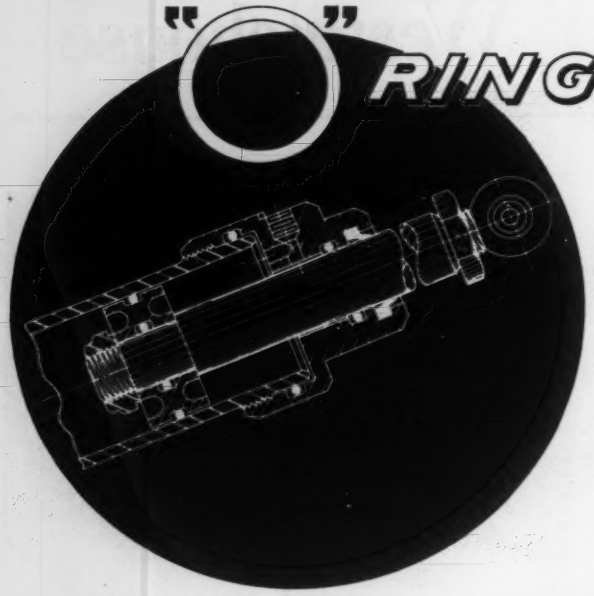
J-07276

Westinghouse

GEARED DRIVES

WESTINGHOUSE W

LINEAR "O" RINGS



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Write today for new free Bulletin No. 493 giving complete data on models and prices.

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THE SKINNER CHUCK COMPANY
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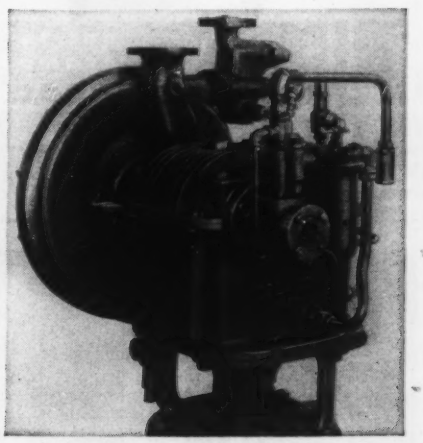

De Laval-IMO lubrication and governor oil pump direct connected to high speed turbine shaft.

Pumps oil at 5800 rpm

De Laval-IMO pumps can be direct connected to high speed shafts. No space consuming gear reductions are necessary. Pump capacity is high compared to its size and weight.

Investigate the IMO if you need a dependable, high speed, pulsation-free pump for lubricating oils, fuel oils, hydraulic control fluids or viscous liquids.

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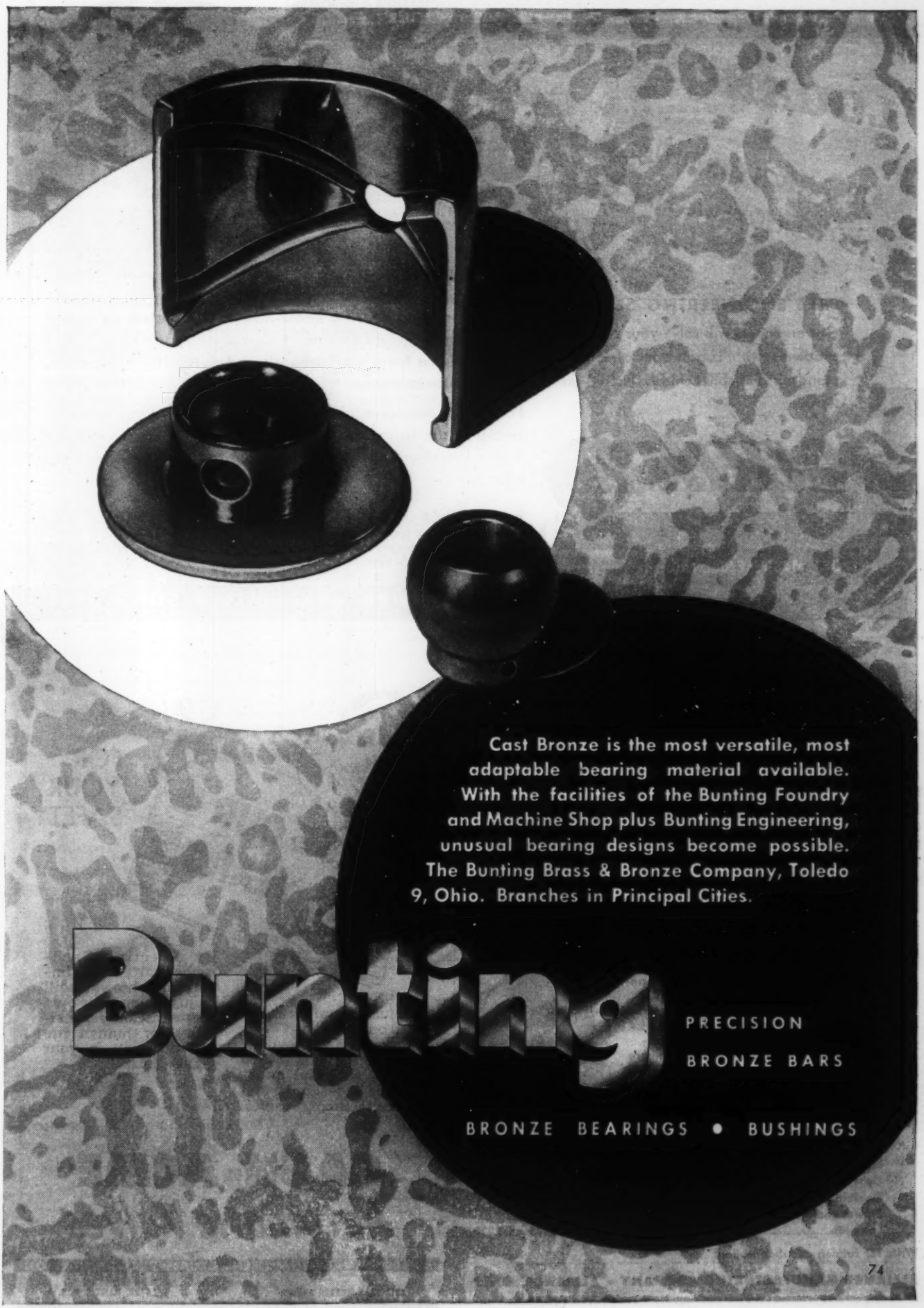
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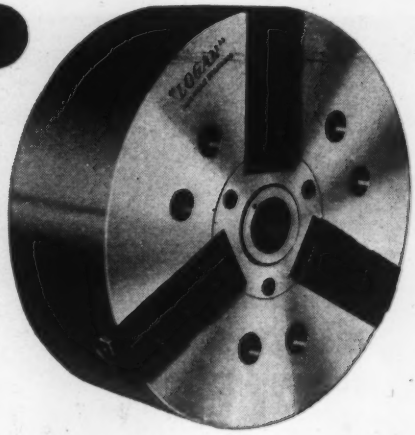

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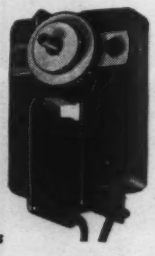
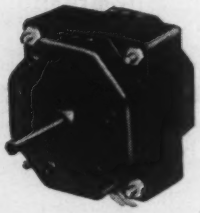
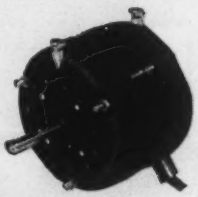


MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.





MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.

MODEL MS
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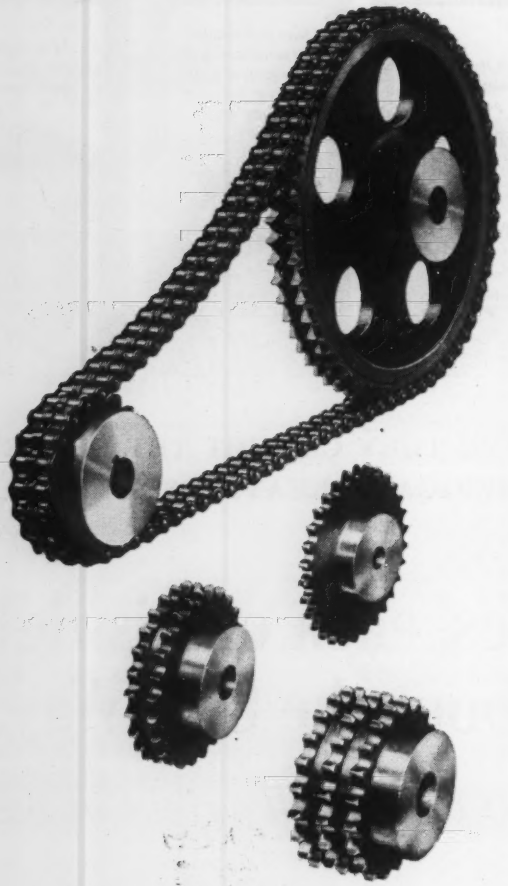

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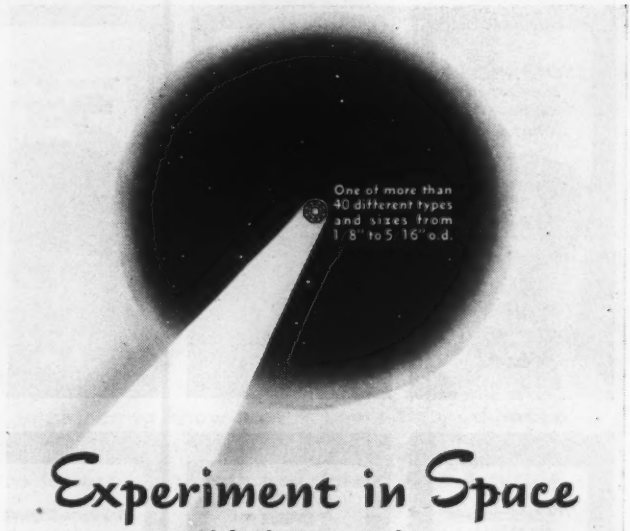

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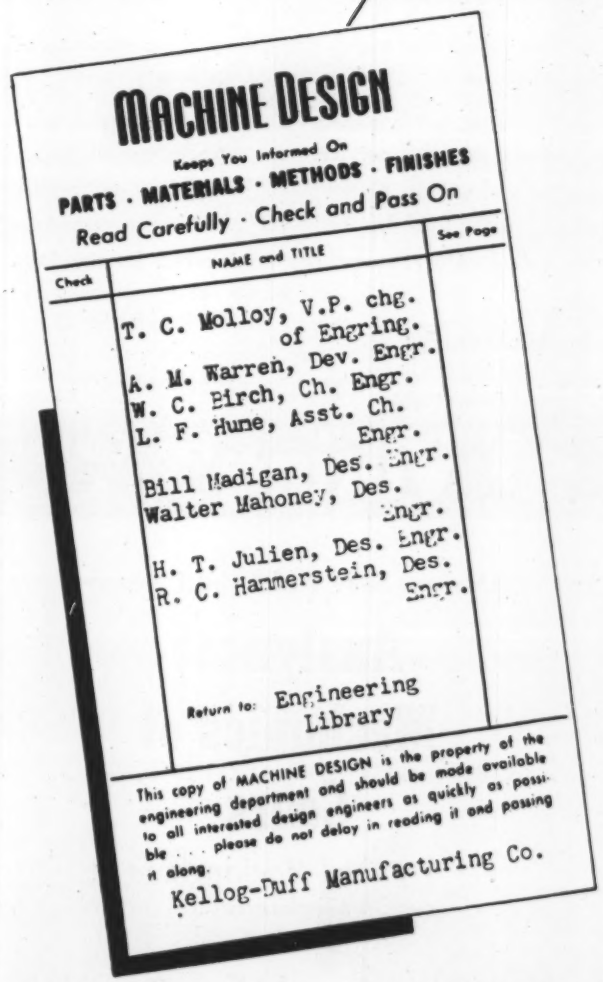

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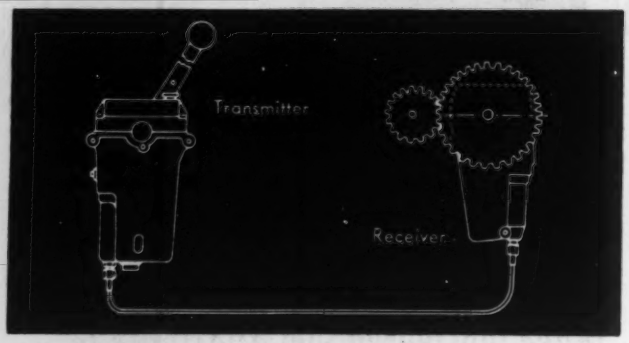

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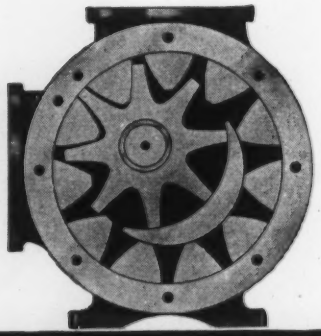

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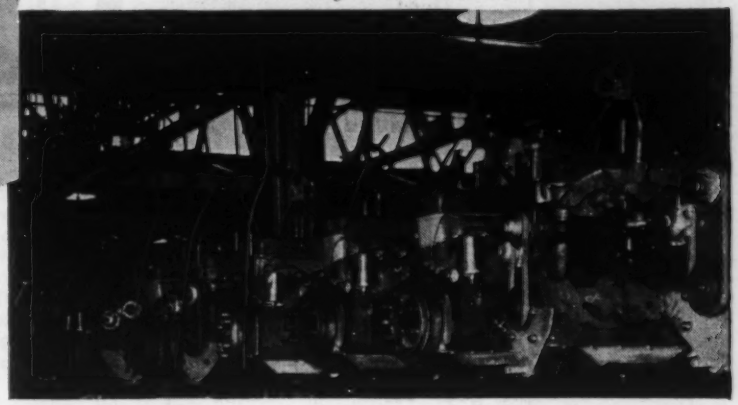

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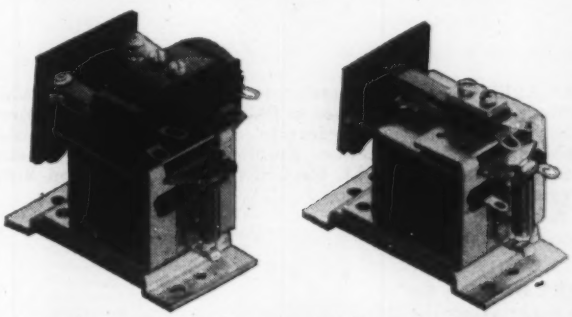

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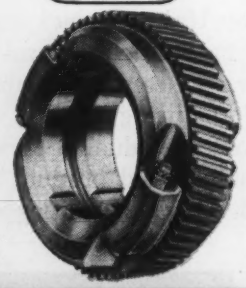

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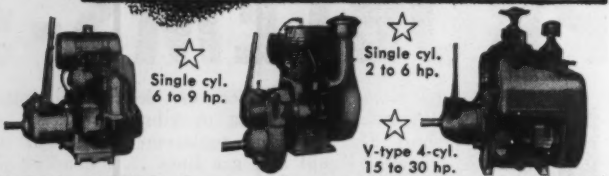

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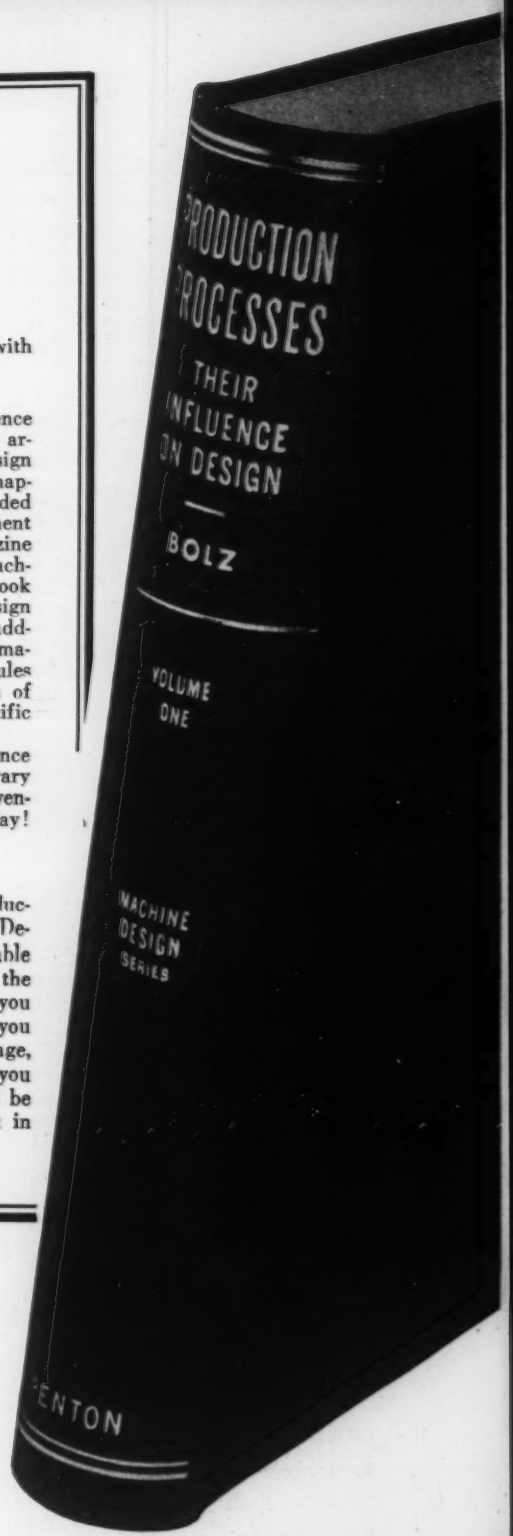

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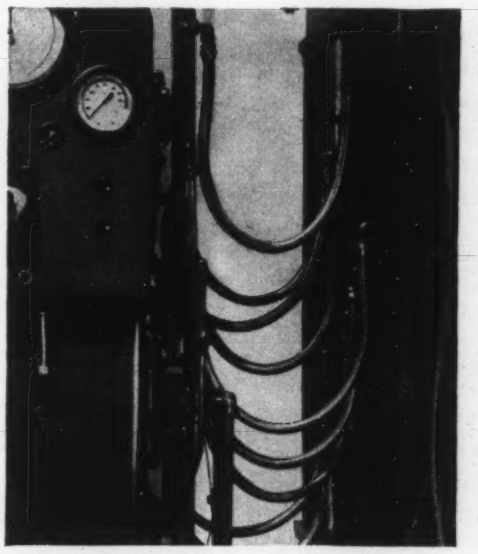

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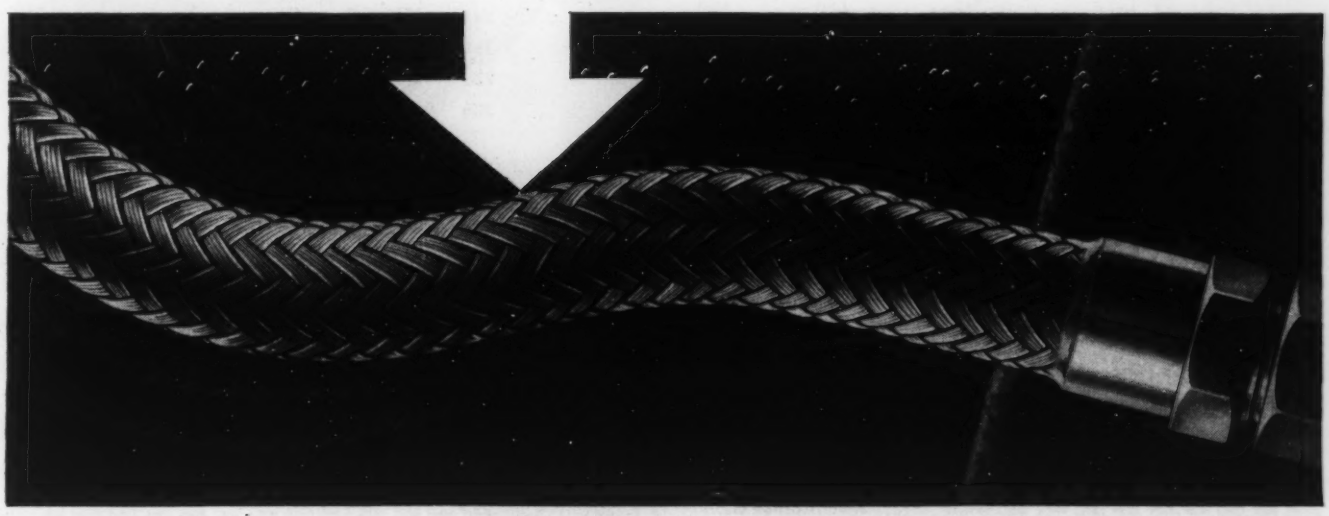

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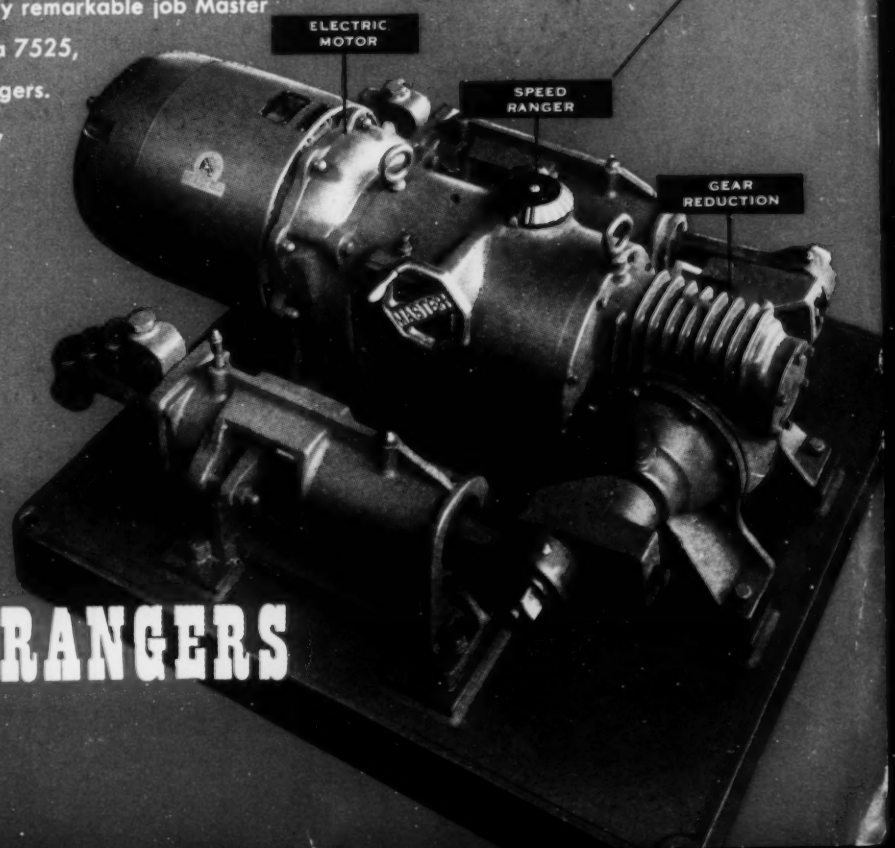
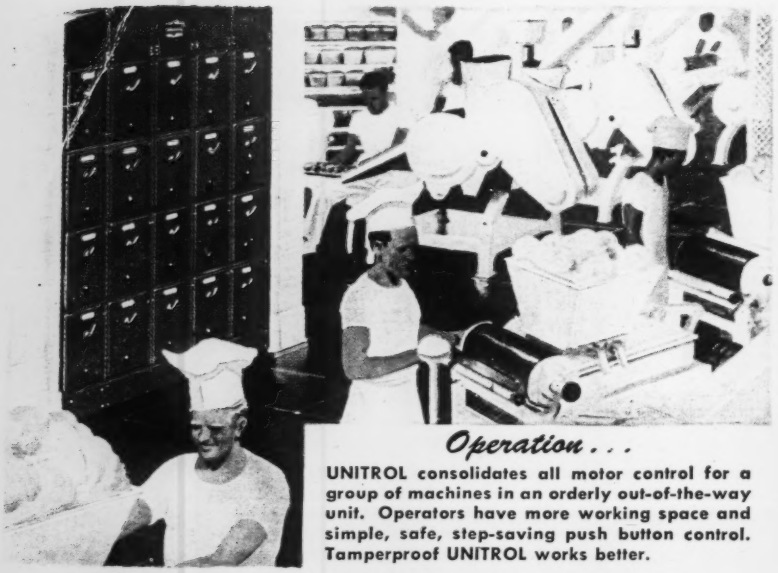
THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO



especially when you use

MASTER SPEEDRANGERS

Better in every way

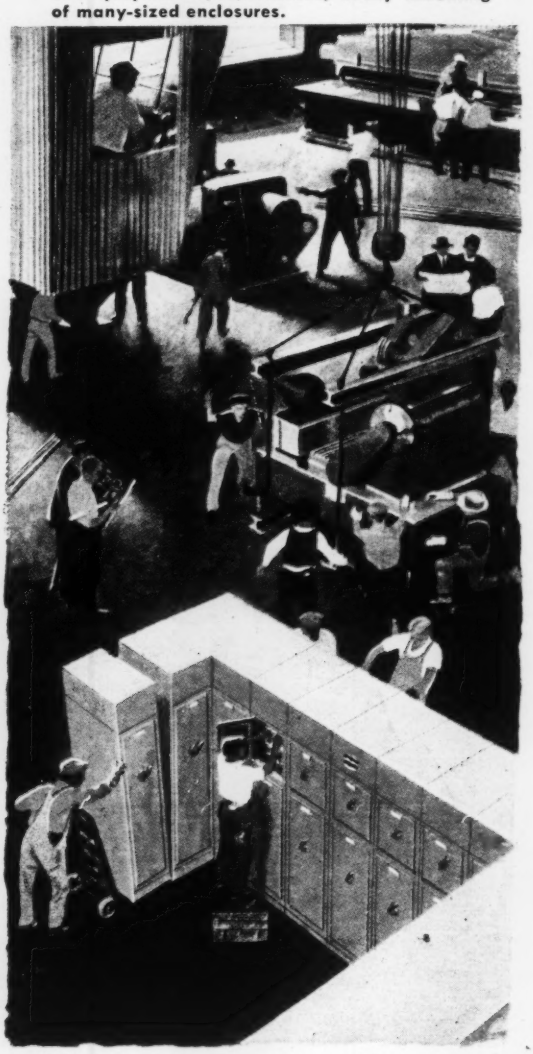


Operation . . .

UNITROL consolidates all motor control for a group of machines in an orderly out-of-the-way unit. Operators have more working space and simple, safe, step-saving push button control. Tamperproof UNITROL works better.

Installation . . .

UNITROL simplifies the entire problem of planning and installing motor control equipment. No extra building construction, no special wall or floor preparation, no tedious, costly mounting of many-sized enclosures.



Maintenance . . .

UNITROL's close grouping of control equipment, usually widely scattered throughout a plant, makes inspection more convenient, safer, more certain of regular attention.

UNITROL solves long-standing problems from the very moment it is first considered until the last day it is in service. In the beginning, it simplifies the entire problem of planning any required installation of motor control equipment. Its dimensions are known and its layout made part of the floor plans. Its cost, too, can be estimated accurately. Next, UNITROL saves time and expense in installation. No special wall or floor preparation is required; no tedious, costly mounting and wiring of many-sized enclosures. Then, in operation, UNITROL consolidates motor control to provide more space for machine operators and for materials handling; simpler, safer, tamperproof push button control. And finally, UNITROL simplifies the maintenance attention which any equipment as important as motor control must have. The close grouping of controls in UNITROL makes inspection more convenient, safer, more certain of regular observance. When you next need motor control, for a single machine, a group of machines, or an entire plant, insist on UNITROL. Write today for your copy of the UNITROL book. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

The name UNITROL *is a Cutler-Hammer trade mark registered in the United States Patent Office. It identifies the genuine and original standardized flexible control center, an outstanding engineering achievement pioneered by Cutler-Hammer, Inc.*

CUTLER-HAMMER

UNITROL

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